# South East Water

## Defra Reporting on Adaptation to Climate Change

**Full Report**

January 2011

ATKINS

Plan Design Enable

ATKINS

# South East Water

# Defra Reporting on Adaptation to Climate Change

## Full Report

### January 2011

#### Notice

This document and its contents have been prepared and are intended solely for *South East Water's* information and use in relation to *Climate Change Adaptation Report*. *Atkins Limited* assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.



#### Document History

| JOB NUMBER: 5044447/950 | | DOCUMENT REF: SEW Climate Change Adaptation Report_Final.docx | | | | |
|---|---|---|---|---|---|---|
| v1.1 | Task 1 – draft for internal review | RMc/JW | GD | BA | | |
| v1.2 | Task 1 – final draft | RMc/JW | GD | BA | BA | 15/10/10 |
| v1.3 | Tasks 1&2 – draft for internal review | RMc/JW | GD | BA | BA | 02/11/10 |
| v1.4 | Tasks 1&2 – final draft | RMc/JW | GD | BA | BA | 24/11/10 |
| v2.0 | Full draft for external review | RMc/JW | GD | BA | BA | 10/12/10 |
| v3.0 | Final draft | RMc/JW | GD | BA | BA | 21/01/11 |
| v4.0 | Final | RMc/JW | GD | BA | BA | 27/01/11 |
| Revision | Purpose Description | Originated | Checked | Reviewed | Authorised | Date |

Plan Design Enable

ATKINS

# Contents

## Section

## Page



## Appendices

## List of Tables



## List of Figures

# Executive Summary

## 1. Information on organisation

*Name of organisation*

South East Water.

*Organisation's functions, mission, aims, and objectives affected by the impacts of climate change*

South East Water is a 'Water Only Company' operating within the UK regulated water sector. It operates 24 hours a day, 365 days of the year supplying drinking water to over two million people in nearly 900,000 properties.

In South East Water's Strategic Direction Statement (SDS) published in 2007, the Company set out the following vision:

- To be recognised as the leading water supplier in the South East of England.
- To deliver a first class 24-hour service in the community, which our customers consider is both value for money and which exceeds their expectations.
- To take a long term view in all that we do to help protect our environment.

The Company aims to achieve this vision by meeting the following three goals:

1. Delivering an excellent level of service from all areas of our business
2. Creating value for our community, our shareholders, and other stakeholders
3. Improving the environment

Climate change will have direct and indirect impacts on how the Company provides its services to customers, and hence its ability to meet these goals. However, customers will not expect their water supply to be affected – whatever the climatic circumstances; they will anticipate that the company has taken all the action needed well before an event. Reduction in water availability and increasing demand in warmer, drier summers will need to be balanced with the potential increase in winter recharge to ensure year-round supply of water for customers. Changing water availability will also affect the environment under the Company's jurisdiction, including a number of SSSIs, which may be affected by low flows and increased risk of multi-season droughts. Climate change will also put assets at risk from heavy rainfall events, which may increase the chance of power outages, interruptions to supply and the ease of maintenance because of access problems. These challenges will affect the Company's ability to continue and improve its level of service whilst still providing value for money for both customers and shareholders.

For more information, see **Sections 2 and 3** of the main report.

## 2. Business preparedness before Direction to report was issued

*Has your organisation previously assessed the risks from climate change?*

The company has met all regulatory requirements in considering the impact of climate change upon its functions. SEW undertakes strategic planning and operates in line with the UK water sector's well developed framework for business planning, water resources planning and drought management. As part of this, SEW has forecast its supply and demand for the next 25 year period, and prepared detailed investment proposals to maintain quality, resilience and quantity of water for the next 5 years as part of its Business Planning process.

In addition work on climate change has been undertaken for other functions, for example in relation to flood risk. However, more work now needs to be done in view of UKCP09 and subject to a change in regulatory directions, which to date have not focussed on climate change risks and resilience and the need for adaptation.

Details of impacts are further discussed in Section 4 of this Summary below and are included in **Section 3** and **Appendix 2** of the main report.

*If so, how were these risks and any mitigating action incorporated into the operation of your organisation?*

The risk assessments undertaken to date have only led to some actions being incorporated into SEW operations, for example in relation to resilience to flood risk. Other action, for example in relation to water resources, depends on future regulatory approval.

SEW's operational sensitivity and business preparedness to current climate is exemplified in its response to the most recent drought: between November 2004 and February 2007. Consecutive dry winters representing the driest period since records began in 1883 resulted in the Company imposing a hosepipe restriction on its customers. However, the Company's efforts to reduce the impact of the drought in accordance with its Drought Plan (including increased leakage detection activity and working with customers to demonstrate how they could save water during the drought) resulted in the continued delivery of a high level of operational service to its customers characterised by, amongst others, the following achievements:

- Maintaining leakage below the 'economic level';
- Maintaining treatment works, reservoirs and the pipe network in a stable condition; and
- Keeping supply interruptions to within the target level.

# 3. Identifying risks due to the impacts of climate change

*What evidence, methods, expertise and level of investment have been used when investigating the potential impacts of climate change?*

The investigation into climate change risks and adaptation options has been carried out by Atkins Limited and follows the process set out by Defra (Defra, 2009). Atkins' team of climate change and water resources experts worked in conjunction with SEW staff in identifying and prioritising risks and assessing adaptation options.

Potential climate change impacts were collated from industry documents, SEW documents and from dialogue with SEW staff. Each document was reviewed for any assessment or data in relation to climate change – quantitative or qualitative. All impacts identified were entered into an impacts matrix, in addition to any quantitative information that was subsequently used by the Company in, for example, their Water Resources Management Plan.

From the initial assessment, there were areas where climate change assessment work was not identified, so further information was gleaned from email and telephone conversations with appropriate experts within the Company. This gave a more comprehensive impacts list, despite formal assessment not always being available. The matrix contained a 'confidence' element, allowing a distinction to be made between the various sources of information and data.

Once the matrix was completed based on these initial sources, a gap analysis was undertaken at a workshop with SEW staff. The matrix was forwarded to the attendees in advance of the workshop, and they were asked to consider whether the gaps identified were genuine gaps or whether the appropriate information or reports had not been included. Where genuine gaps were found, the attendees were asked to consider whether each gap is specific to SEW or whether it is a gap for the water industry as a whole.

For more information, see **Section 3** of the main report.

# 4. Assessing risks

*How does your organisation quantify the impact and likelihood of risks occurring?*

Quantification of climate change risks is undertaken by specific departments of SEW in response to regulatory requirements, such as the Water Resources Management Plan. Where this analysis has been carried out, the information has been carried through to inform the risk assessment; however, a separate quantitative assessment has not been considered necessary for Adaptation Reporting purposes.

The impact of climate change on the constituent parts of the supply-demand balance has been assessed as part of the WRMP. Examples of completed analyses include:

- The impact of climate change has been factored into forecasts of Deployable Output for both surface and groundwater using the UKCIP02 Medium scenario ('Mid'). Uncertainties have been included in the target headroom allowance, using the CCSR/NIES General Circulation Model (GCM) as a conservative estimate ('Wet') and the ECHAM4 GCM as a worst-case scenario ('Dry').
- SEW has modelled the impact of climate change on recharge at the individual source level. An increase in recharge is included as part of the 'Wet' scenario as described above.
- A study for the Company on the impact of climate change demand found average demand will increase by 2.6% under the Medium UKCIP02 scenario (and 1.3 and 4% under the 'Wet' and 'Dry' scenarios – as above – respectively) by the 2020s (HR Wallingford, 2007). The 'Mid' scenario was found to be higher than the previous Periodic Review, PR04 (1.7%) and national average in a national study, CC:DeW (1.3%).
- For leakage, conditions for freeze-thaw weathering (frost days, or number of days where the minimum daily temperature is less than 0°C – which are most critical in influencing leakage) were found to be reduced under Low, Medium and High scenarios of UKCIP02 at test locations of Oxford and Eastbourne. Frost days decreased by up to 10 days per year by the 2020s under the 'Mid' scenario.

*Provide here a brief summary of the methodological approach to quantification where this has been possible and your categorisation of likelihood and impact.*

To prioritise adaptation action towards significant impacts, with reference to the approach advocated in Defra's guidance, each climate risk was assigned a qualitative risk indicator of 'Low', 'Medium', 'Medium-High' or 'High'. This is a qualitative assessment, but was based on explicit assessment of components of vulnerability and on other evidence included in the aforementioned impacts matrix (described below), supported by a risk scoring exercise undertaken with SEW staff.

Information included in the impacts matrix to support the assessment of significant impacts included:

- The business function to which the impact relates;
- The relevant climate variable(s);
- A description of the impact;
- Sensitivity of the business function/receptor to change in climate variables;
- Changes in exposure from changes in the relevant climate variable(s); and
- Whether an assessment of the risk has been undertaken.

Levels of confidence have been assigned to risks on the basis of the pedigree of the evidence used to identify them. Therefore, a quantitative analysis by the Company is afforded the highest level (A), and levels of decreasing pedigree are assigned for qualitative Company study (B), quantitative industry-wide study (C), qualitative industry-wide study (D), and finally, dialogue with Company staff (E).

The 'Overall Risk' category described above was used to prioritise risks to carry through for adaptation action. Priority risks can be considered as those which are considered to result in the most significant impact

on SEW or its stakeholders, or/and those which require immediate practical action or investigation. As discussed above, the workshop held with SEW staff was used as an opportunity to identify the most pressing risks for SEW's operations and stakeholders from the perspectives of specialist staff across the Company.

Those impacts that were considered to pose a Medium-High or High risk to the Company were taken forward to the next stage.

For more information, see **Section 3** and **Appendix B** of the main report.

# 5. Uncertainties and assumptions

*What uncertainties have been identified in evaluating the risks due to climate change?*

Uncertainty is inherent in climate change assessments, and through probabilistic projections from UKCP09 they are now a feature of the climate data available in the UK. However, the assessments carried out by SEW pre-date the publication of UKCP09, therefore it should be noted that quantitative assessments carried out by the Company to-date use previous climate scenarios as a source of data. Where they have been used, the uncertainty has been quantified by taking 'Mid', 'Wet' and 'Dry' scenarios or models to represent the spread in the projections. These are used, for example, in calculating headroom.

Uncertainty is also included in the assessment of adaptation options, as part of the identification of barriers to successful implementation and also with regard to potential regret. For example, if there is uncertainty with regard to the suitability or likely success of an adaptation option, it is more likely to be classed as medium or high potential regret. Potential regret must, however, be balanced against an assessment of the risk to SEW's business and customers of doing nothing. This emphasises the potential benefit of using a threshold-based approach where possible, not based on climate per se but one that identifies the conditions under which particular tipping points may occur (e.g. impacts on treatment of drinking water or wastewater) and the risks they would impose on the business.

*What assumptions have been made?*

In evaluating climate risks company specific assessments have been used where available; these are based on industry wide approaches and evidence, supported by UK Water Industry Research (UKWIR) and Environment Agency research and as directed by regulators. Where climate change analysis has not been undertaken by the Company directly, evidence of risks is often taken from industry-wide studies. Therefore, there is an assumption that the methodologies from such research are robust and that the implications for SEW are reliable.

For more information, see **Section 3** of the main report.

# 6. Addressing current and future risks due to climate change – summary

Note: N/A is used where an adaptation option is already taken into account or is not proposed in this adaptation plan.

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| **Water Resources** | | | | | | |
| **Reduction in surface water availability** | Not formally assessed by SEW. | The impact of climate change on DO has been factored into forecasts of DO, using the UKCIP02 Medium scenario ('Mid'). Uncertainties have been included in the target headroom allowance, using the CCSR/NIES model as a conservative estimate ('Wet') and ECHAM4 as a worst-case scenario ('Dry').<br><br>Headroom modelling followed UKWIR (2002) guidance; triangular distributions were skewed to 60% dry, 40% wet. | Reductions in rainfall, particularly during consecutive seasons, with corresponding increases in year-round PET can reduce reservoir refill capability. Winter recharge is likely to increase, though how changes in interannual variability are more uncertain. | Develop conjunctive use schemes | Further investigation and consultation will be undertaken in preparing the next WRMP. If options feasible, regulatory support required to allow implementation. | During WRMP drafting. |
| | | | | Increase reservoir capacity | Further investigation and consultation will be undertaken in preparing the next WRMP. If feasible, regulatory support required to allow implementation. | During WRMP drafting. |
| | | | | Reduce water lost through leakage | Already underway, although ultimately limited by SELL. | Regular monitoring already undertaken and reported annually via June Return. |
| | | | | New surface water abstraction | This option will be investigated. | During WRMP drafting. |
| | | | | Inter-company transfer | Liaising with bulk suppliers regarding future options with respect to climate change. | During preparation of WRMP (in partnership with other companies). |
| | | | | Intra-company transfer | Further opportunities will continue to be reviewed as options for the next WRMP | During WRMP drafting. |
| | | | | Maximising reservoir yield | Capital Maintenance Plan surveys and future option work | Next renewal of Capital Maintenance Plan |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | | | | Effluent re-use | Further investigation and consultation will be undertaken in preparing the next WRMP. If feasible, regulatory support required to allow implementation. | During WRMP drafting. |
| **Increased competition for shared water resources** | Not formally assessed by SEW. | Not formally assessed by SEW. | The Water Resources in the South East (WRSE) Group, driven by the EA, may require companies to work more closely in managing shared resources, e.g. the River Medway Scheme and Southern Water. Greater numbers of sustainability reductions may also be imposed. Climate change is likely to emphasise a much more integrated strategy across the region. | Potential options to be explored through the WRSE Group | Potential options to be explored through the WRSE Group | During WRMP drafting. |
| **Risk of non-renewal of time limited licences or existing licences being modified** | Subject to the findings of EA investigations | Not formally assessed by SEW. | SEW operates in a water stressed area so there is already increasing scrutiny and risk to existing abstraction licences. This is likely to increase with a change in climate due to changes in hydrology. Increases in evapotranspiration and lower rainfall in summer periods will result in lower flows in rivers. Increases in rainfall intensity may result in flashier river flows, reducing the period of time available to exploit peak flows. Licences may need to be altered to maintain the balance between environmental needs and public water supply. | N/A | N/A | During WRMP drafting. |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| **Increasing demand in warmer weather** | Not formally assessed by SEW beyond requirements of WRMP and BP processes.<br><br>Some consideration of demand as a trigger for drought in the Drought Plan, for past/current conditions only: worst-case scenarios for ADD and ADPW used as drought trigger - currently 2002/03 demand profile is used for MKW. | Predictive relationships between climate change and demand developed using UKCIP02 Low, Medium and High scenarios<br><br>The uncertainties for demand are large, and have been included within the assessment of Target Headroom (NB, this was based on SEW work, not HRW).<br><br>A separate study for MKW only found average demand will increase by 2.6% (1.3 to 4%) by the 2020s using the same models as in the supply modelling. The 'Mid' scenario is higher than PR04 (1.7%) and national average in CC:DeW (1.3%). | Warmer weather likely to result from climate change is likely to result in increased demand for water, in particular with respect to personal hygiene, washing, domestic garden watering and other external uses of water. | Tariff change to encourage saving water | Implementing also through engagement with partners and through behavioural change. | Review of quantitative and qualitative outputs. |
| | | | | Monitoring customer views on frequency of demand restrictions | Will continue as a question (e.g. for PR14) but an existing Level of Service and regulatory approval in place until 2015. | During PR14 preparation. |
| | | | | Expand discretionary use restrictions | Investigate and include in revised Drought Plan and next Strategic Direction Statement | Will monitor at next dry year. |
| | | | | More input to new housing development planning | Engagement through Local Development Frameworks and Water Cycle Strategies, WRMP consultation, and wider partnerships with the Environment Agency and others. Potential barriers include effectiveness and reliance on engagement particularly of local authorities. Measuring benefits, and the sustainability of those benefits to different climate scenarios. | During WRMP drafting. |
| | | | | Reduce demand through household water efficiency measures and customer marketing campaign | Implement, monitor and make adjustments to demand forecast as appropriate. Barriers include requirement for legislative change. | Ongoing monitoring. |
| | | | | Relaxation of barriers to demand options being funded through price review | Investigate with industry and regulators. | During PR14 preparation |
| | | | | Implement rainwater harvesting and grey-water reuse for domestic/commercial customers | Investigate opportunities to trial. Will need to assess under normal and wider conditions, especially drought i.e. need to understand reliability of systems under prolonged dry conditions etc. | During WRMP drafting. |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | | | | Increase in metering | Already underway. | During PR14 preparation |
| | | | | Monitor demand in relation to weather variables | Baseline completed, but need to examine climate change scenarios, in relation to industry and regulatory guidance. | During WRMP drafting. |
| **Reduction in groundwater availability** | A comparison of 1 in 50-yr droughts compared to 1 in 100-yr (to simulate climate change) showed a total of 15 groundwater sources in WRZ 2-5 will have slightly reduced DO's during a '1 in 100' year drought event; typically -1% to -5% in PDO and -1% to -6% in ADO.<br><br>Some consideration of groundwater levels, recharge and SMD as triggers of drought in the Drought Plan, for past/current conditions only. e.g. for MKW, anything below LTA groundwater level is classed as 'mild ' or 'moderate' drought, below historical | Given the uncertainties that exist around climate change input scenarios and output estimates, the Company has included the difference between the 'Mid' scenario and both the 'Wet' and 'Dry' scenarios as a component of uncertainty in the Target Headroom assessment.<br><br>Headroom modelling followed UKWIR (2002) guidance; triangular distributions were skewed to 60% dry, 40% wet. | Reductions in rainfall, particularly during consecutive seasons, will reduce the amount of groundwater recharge that occurs, hence decreasing the availability of groundwater resources to meet demand. | Develop conjunctive use schemes | Further investigation and consultation will be undertaken in preparing the next WRMP. If feasible, regulatory support required to allow implementation. | During WRMP drafting. |
| | | | | Artificial recharge | Investigations and working with partners. | During WRMP drafting. |
| | | | | Aquifer storage and recovery (ASR) | Investigate as part of optioneering process. | During WRMP drafting. |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | minima is 'severe' drought. Also, below LTA of 3-year cumulative recharge is classed as a 'mild drought', with <80% of LTA and <60% of LTA classed as 'moderate' and 'severe' droughts respectively. | | | Abstraction licence trading | Working with Environment Agency and local business; will feed into next WRMP. | During WRMP drafting. |
| **Increase in winter recharge** | Not formally assessed by SEW. | As part of the WRMP, for both groundwater and surface water sources, SEW has modelled the impact of climate change on recharge at the individual source level. An increase in recharge is included as part of the 'Wet' scenario as described above. | Increase in winter rainfall providing the opportunity for increased recharge and storage. | None specifically. But ensure impacts of 'wet' scenarios on other options are understood | Investigate as part of optioneering process. | During WRMP drafting. |
| **Asset Management** | | | | | | |
| **Increase in risk of fluvial flooding** | Where available, a range of AEPs is considered but typically flood data is limited to Environment Agency Flood maps showing only Flood Zones 3 and 2. Where detailed hydraulic modelling has been carried out by the Environment Agency then usually flood events ranging from 1 in 10 to 1 in 100 AEP | Not formally assessed by SEW. | Increased frequency of extreme rainfall events will heighten the risk of river levels rising and causing fluvial flooding of water company assets. | Review any Flood Risk Assessments that cover areas where SEW assets are sited | Monitoring effectiveness of chosen solutions and reviewing the assumptions in PR09/14 to ensure they remain valid. | During PR14 preparation |
| | | | | Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments | Continued development of climate change assessment in WRMP and BP processes. Monitoring effectiveness of chosen solutions and reviewing the assumptions in PR09/12 to ensure they remain valid. | During PR14 preparation |
| | | | | Manage expectations of level of service provision during flood events | Communications team to investigate. Also industry work regarding levels of service and flooding (service-ability) | Review in relation to any future incidents. |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | are available including a climate change scenario using the 1 in 100 AEP event but with flows increased by 20% (in the South East this climate change event tends to equate to 1 in 200 AEP flood levels). | | | Implement protection or flood-proofing of assets at high risk of fluvial flooding | Some implemented, but limited by funding. Investigations will examine longer-term projections. | During PR14 preparation |
| | | | | Incorporate climate change impacted flood events into topographic mapping/asset risk tool | Incorporate assessments into Asset management Planning and future BP submissions | Monitor how used in decision-making |
| | | | | Amend assets' insurance policies to reflect climate change-impacted flood risk | To be reviewed. | To be reviewed by 2012. |
| **Increase in risk of groundwater flooding** | As above | Not formally assessed by SEW. | Increased frequency of extreme rainfall events will heighten the risk of groundwater levels rising and causing flooding of both underground and above-ground water company assets. Flooding of service trenches will also inhibit the ability of SEW to repair leaks. | Review and upgrade where necessary pump duty and pump type at borehole sites | Assess future conditions | During PR14 preparation |
| | | | | Implement changed operation and maintenance regime to deal with higher groundwater levels | Investigation planned | During PR14 preparation |
| | | | | Ensure that future below ground installations (e.g. meters) are waterproof | Investigate potential future changes | During PR14 preparation |
| | | | | Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments | Investigations planned. | During PR14 preparation |
| | | | | Raise headworks | Investigate whether others vulnerable. | During PR14 preparation |
| **Increase in risk of surface water flooding** | As above | Not formally assessed by SEW. | Increased frequency of extreme rainfall events will heighten the risk of surface water flooding of water company assets, | Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments | Further investigations | During PR14 preparation |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | | | particularly in areas where SUDS are not present. Flooding will also reduce the mobility of SEW staff to access sites and detect and repair leaks in inundated areas. Risk of flooding exacerbated where development results in permeable surfaces are replaced with paved areas within catchments. | Review any Surface Water Management Plans that cover areas where SEW assets are sited | Further investigations | During PR14 preparation |
| | | | | Manage expectations of level of service provision during flood events | Communications team to investigate. Also industry work regarding levels of service and flooding (service-ability) | Review in relation to any future incidents. |
| | | | | Implement protection or flood-proofing of assets at high risk of surface water flooding | Some implemented, but limited by funding. Investigations will examine longer-term projections. | During PR14 preparation |
| | | | | Incorporate climate change impacted flood events into topographic mapping/asset risk tool | Incorporate assessments into Asset management Planning and future BP submissions | Monitor how used in decision-making |
| | | | | Amend assets' insurance policies to reflect climate change-impacted flood risk | To be reviewed | To be reviewed by 2012. |
| **Increase in risk of tidal/coastal flooding** | Not formally assessed by SEW. | Not formally assessed by SEW. | Sea level rise may expose SEW assets to both erosion and flooding with saline water. Impacts will clearly be greater at coastal sites, but those situated on estuaries will also be vulnerable. Consideration of the risk of tidal flooding may also limit the favourability of particular resource options, e.g. desalination plants, in future options appraisals. | N/A | N/A | During WRMP drafting. |
| **Risk to dam safety** | Panel engineer responsible for ensuring dams and reservoirs meet safety | Panel engineer responsible for ensuring dams and reservoirs meet safety standards. But has not | This impact relates to the capacity of dam spillways to deal with high volumes of water from extreme rainfall events that | Review industry guidance and incorporate into assessments in reservoir safety | To be reviewed | During PR14 preparation |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | standards. But has not formally assessed these thresholds. | formally assessed these thresholds. | could lead to dam overtopping and erosion of the embankment materials, leading to dam failure. The structural stability and therefore safety of dams is also vulnerable to extended periods of low rainfall, fluctuations in water level and extremes of temperature. The results of these climatic impacts, respectively, include desiccation of clay cores, increases in pore pressure leading to erosion, and thermal cracking. | | | |
| **Risk to structural stability of dams** | Panel engineer responsible for ensuring dams and reservoirs meet safety standards. But has not formally assessed these thresholds. | Panel engineer responsible for ensuring dams and reservoirs meet safety standards. But has not formally assessed these thresholds. | Soil conditions may exhibit increasing variability as a result of changes in inter-annual temperature and rainfall regimes, which may affect slope and structural stability, as described above. | Review industry guidance and incorporate into assessments in reservoir safety | To be reviewed | During PR14 preparation |
| **Increase in heave-related leakage / burst frequency** | Not formally assessed by SEW. | The Company expects that its ageing asset base will further exacerbate the risk of bursts in future. | Reducing soil moisture in dry spells will increase the risk of heave and associated damage to pipes. Greater extremes of wet and dry cycles causing greater soil movement. | Incorporate impacts of soil wetting and drying due to climate change scenarios into SEW's existing capital maintenance planning model | Use model to understand potential climate change impacts. | During PR14 preparation |
| | | | | Use heave-resistant pipeline materials and connected assets for system extensions/renewals | Continue to review pipe materials available | Ongoing |
| **Decrease in freeze-thaw damage to pipes and assets** | Not formally assessed by SEW. | UKCIP02 climate scenarios showed a reduction in the number of frost days (no. days per month where min temperature is <0°C) at test locations of Oxford and | Low temperature extremes and snowfall are predicted to decrease thus reducing the risk of burst frequencies and leakage through freeze-thaw weathering, | N/A | N/A | During PR14 preparation |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | | Eastbourne.<br><br>Frost days will decrease by up to 10 days per year by the 2020s under the 'Mid' scenario. | | | | |
| **Increased risk of sedimentation/siltation** | Not formally assessed. A risk in some specific reservoirs, but not all. | Not formally assessed by SEW. | Extreme rainfall events will cause increased runoff rates and increased sediment mobility, resulting in increased conveyance of fine sediment and also large sediment into reservoirs and rivers, causing siltation. | N/A | N/A | During PR14 preparation |
| **Asset deterioration through sediment settlement** | Not formally assessed by SEW. | Not formally assessed by SEW. | Multi-season low rainfall events would reduce the frequency of flushing flows passing through catchments, resulting in potential siltation of intake structures, particularly on rivers. | N/A | N/A | During PR14 preparation |
| **Variable water quality affecting treatment processes** | Not formally assessed by SEW. | Not formally assessed by SEW. | Greater variability in water quality as a result of both variable dilution potential associated with flow extremes and differing pollutants in raw water from altered land practices, may affect the efficacy of water treatment processes. Single-stage treatment processes will be particularly vulnerable to this. | Review industry research and monitor outage events | To be reviewed | During PR14 preparation |
| **Increase in outages from bad weather affecting assets and** | Not formally assessed by SEW. | Not formally assessed by SEW. | The frequency of outage events resulting from both extreme rainfall and low flow is likely to | Review existing outage response procedures more frequently | Investigate how often procedures should be reviewed and implement | During PR14 preparation |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| **power supply** | | | increase with climate change. Outages from more persistent environmental change and cumulative effects of causal factors can also lead to an increase in outage frequency. An increase in outage will impact SEW's supply-demand balance and the operation of sites. This may also impact upon SEW's DG3 'interruptions to supply' reporting, which is considered by the economic regulator, Ofwat. | Investigate alternative outage response procedures | Investigate as described | During PR14 preparation |
| | | | | Continue to monitor outage events using standardised template across sites | As described, especially for bad weather | During PR14 preparation |
| | | | | Review bad weather site operation procedures | Investigate further requirements with respect to potential changes in weather | During PR14 preparation |
| | | | | Use of weather-related outage as a criterion for capital scheme selection | Investigate further. Also to consider related decision-making methods as company and industry. | During PR14 preparation |
| **Maintenance access difficulties in bad weather** | Not formally assessed by SEW. | Not formally assessed by SEW. | Access to SEW sites for operations staff and delivery vehicles or the ability to operate leak detection and repair services may be inhibited by extreme rainfall and flooding. | Covered under general resilience methods | N/A | During PR14 preparation |
| **Water Quality** | | | | | | |
| **Saline intrusion** | Not formally assessed by SEW. | For those sites affected, the estimate of impact from the mid range climate change analysis has been included within the central estimates of climate change impacts on groundwater DO, with the range estimates from the low (wet) and high (dry) scenario analyses being included within the target headroom analysis | Rising sea levels may cause salinity of groundwater sources, thus making them inoperable, sometimes permanently. This impact is more likely to affect sources at/near the coast. | N/A | N/A | During PR14 preparation |
| **Risk of aquifer contamination from** | Not formally assessed | Not formally assessed by | Extreme rainfall events and associated increases in | N/A | N/A | During PR14 |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| **flooding** | by SEW. | SEW. | groundwater flooding may result in conveyance of pollutants through groundwater into aquifers. Existing groundwater source treatment processes may become inadequate. | | | preparation |
| **Increased land runoff** | Not formally assessed by SEW. | Not formally assessed by SEW. | Increased surface runoff, identified above as being a direct result of extreme rainfall events, will provide increasing capacity for agricultural fertilisers, pesticides, herbicides and nutrients to be conveyed to river channels and thus affecting quality of sources of raw water.<br><br>Additional risk of N & P pollution | Consider as part of catchment management plans (such as WFD programme of measures), with climate change | To be reviewed | During PR14 preparation |
| | | | | Monitor and review; research into potential future changes | Will investigate. Barriers include level of support from stakeholders and partners and regulatory funding. Will engage with other companies who have funded land management projects. | During WRMP drafting. |
| | | | | Liaison with stakeholders (e.g. NFU) | To be reviewed | During PR14 preparation |
| | | | | Education and awareness on management practices for land owners | To be reviewed | During PR14 preparation |
| **Reduction in water volumes and pollution dilution** | Not formally assessed by SEW. | Not formally assessed by SEW. | Multi-season low rainfall and associated low flows in rivers, reservoirs and aquifers, would result in lower dilution potential for pollutants – particularly sewage – and consequently higher raw water concentrations entering treatment works. | Review industry research and guidance | N/A | During PR14 preparation |
| **Increased algae risk in reservoirs** | Not formally assessed. A risk in some specific reservoirs, but not all. | Not formally assessed by SEW. | Lower summer flows, higher temperatures and increased solar incidence are likely to increase the risk of larger and | Review industry research and guidance | N/A | During PR14 preparation |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | | | more frequent algal blooms in reservoirs. This will heighten the need for treatment, thus increasing OPEX and potentially necessitating a capital solution. | | | |
| **Increased risk of cryptosporidium in reservoirs** | Not formally assessed. However, residence times in reservoirs of above 7 days reduces risk. | Not formally assessed by SEW. | Higher demands as a result of increased temperatures and lower summer rainfall will mean reservoirs are drawn down more rapidly. Low residence times can increase the risk of cryptosporidium in reservoirs, thus putting sources at risk. | Review industry research and guidance | N/A | During PR14 preparation |
| **Increased risk of turbidity** | Not formally assessed. A risk in some specific reservoirs, but not all. | Not formally assessed by SEW. | Extreme rainfall events can result in flashy river flow regimes. This in turn leads to greater disturbance of benthic sediment which, along with greater sediment conveyance from surface runoff, can cause increased turbidity risks at water treatment works. High turbidity levels often result in auto-shutdown of treatment works, thus impacting supply. | Review industry research and guidance | N/A | During PR14 preparation |
| **Increasing nitrates / mobilisation of fines** | Not formally assessed by SEW. | Not formally assessed by SEW. | Extreme rainfall events (particularly after dry periods) will result in the mobilisation of large quantities of fine sediment. This will result in a heightened risk of siltation at intake structures and increased mobility into raw water of bound nutrients, potentially impacting treatment efficacy.<br><br>Additional risk of N & P pollution | Review industry research and guidance | N/A | During PR14 preparation |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| **Reduced dissolved oxygen in surface waters** | Not formally assessed by SEW. | Not formally assessed by SEW. | Higher temperatures and/or reduced flows may cause a reduction in dissolved oxygen in surface waters; increasing the need for further treatment because of the reduced ability of receiving waters to cope with pollution. | Review industry research and guidance | N/A | During PR14 preparation |
| **Increased efficiency of water treatment processes** | Not formally assessed by SEW. | Not formally assessed by SEW. | Increased temperatures will speed up chemical and biological treatment processes for water | Review industry research and guidance | N/A | During PR14 preparation |
| **Energy & Carbon** | | | | | | |
| **Increasing energy demand in warmer/drier weather** | Demand is forecasted on an annual basis in the water resources plan and then revised and reforecast as necessary on a monthly basis. Dry year demand is used as a basis for forecasting demand in hot spells, but no specific assessment for climate change. | Not formally assessed. Increasing likelihood of hot spells in summer may affect energy demand. | Demand for water increases in warm, dry weather, which increases treatment and pumping requirements and hence energy use. This has both financial and carbon implications. | Already considered as part of WRMP and Business Plan | N/A | During PR14 preparation |
| **Biodiversity & Conservation** | | | | | | |
| **Increasingly difficult management and improvement of conservation areas (e.g. SSSIs)** | Not formally assessed by SEW. | Not formally assessed by SEW. | A changing climate is likely to alter the condition of conservation areas, thus management and preservation of baseline conditions will become increasingly difficult. | Review industry research; an area for future SEW investigation | N/A | During PR14 preparation |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| **Potential difficulty in meeting WFD standards** | Not formally assessed by SEW. | Not formally assessed by SEW. | Climate change may make it more difficult to meet the new WFD standards for all water bodies to be in 'Good' ecological condition. | Review industry research; an area for future SEW investigation | N/A | During PR14 preparation |
| **Potential changes to abstraction licences to protect SSSIs and wetlands** | Not formally assessed by SEW. | Not formally assessed by SEW. | Licensing conditions for abstractions may become stricter in order to protect European designated wetlands in supply areas. | Review industry research; an area for future SEW investigation | N/A | During PR14 preparation |
| **Decrease in base flows in rivers** | Not formally assessed by SEW. | Not formally assessed by SEW. | A decrease in river base flow in summer may result in the need for alterations in the operation of reservoirs to supply rivers with compensation flow (to maintain good ecological status in the basin). | Review industry research; an area for future SEW investigation | N/A | During PR14 preparation |
| **Organisational Capacity** | | | | | | |
| **Lack of staff awareness of climate change and associated impacts and adaptation options** | Not formally assessed by SEW. | Not formally assessed by SEW. | The impact of climate change on operations is likely to impact all SEW staff in some way in the future, e.g. in operation of sites, access to sites or responding to customer enquiries or complaints. | Increase staff awareness | Embed climate change consideration in processes and activities | Monitor |
| **Higher numbers of customer complaints arising from greater frequencies of extreme events** | Not formally assessed by SEW. | Not formally assessed by SEW. | Greater frequencies of extreme events, such as heat waves causing greater frequencies of demand restrictions, and flooding causing disruptions to supply, will result in higher numbers and different types of customer enquiries or complaints. Customers will | N/A | N/A | Monitor |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | | | expect SEW to take all actions such that predicted climate change is planned for. This may in turn impact upon SEW's performance against Ofwat's Service Incentive Mechanism and other comparative assessments. | | | |
| **Increased risk of loss of service from suppliers - e.g. electricity, chemical suppliers, etc** | Not formally assessed by SEW. | Not formally assessed by SEW. | SEW may be affected where suppliers cannot deliver a service on which SEW relies, such as power, supply-chain requirements (e.g. chemicals) and personnel/contractors. | Monitor | N/A | Monitor |
| **Facilities Management** | | | | | | |
| **Increased need for air conditioning in summer and heating in winter** | Not formally assessed by SEW. | Not formally assessed by SEW. | Increased temperature variability may impact upon working conditions for SEW staff, both in offices and vehicles. | Monitor | N/A | Monitor |
| **Potential risk of spread of disease in trees in SEW landholdings** | Not formally assessed by SEW. | Not formally assessed by SEW. | Potential increase in spread of major tree diseases as a result of climate change. Potential liability for trees on SEW landholdings. | Review industry research; an area for future SEW investigation | N/A | Monitor |
| **Potential public health impact of algal blooms in reservoirs used for recreation** | Not formally assessed by SEW. | Not formally assessed by SEW. | Algal blooms in reservoirs may result in safety and public health problems, and potential for claims against SEW because of ill health. | Review industry research; an area for future SEW investigation | N/A | Monitor |
| **Financing** | | | | | | |
| **Vulnerability to political stances on climate change** | Not formally assessed by SEW. | Not formally assessed by SEW. | Changes to political stances in relation to climate change may | Monitor | N/A | Monitor |

| Primary impact of climate variable (e.g. health) | Threshold(s) above which this will affect your organisation | Likelihood of threshold(s) being exceeded in the future and confidence in the assessment | Potential impacts on organisation and stakeholders | Adaptation Options | Proposed action to mitigate impact | Timescale over which action is planned |
|---|---|---|---|---|---|---|
| | | | impact upon SEW if increased scrutiny of adaptation efforts arises which could potentially impact upon the Company's reputation. It may also require the Company to focus more on particular measures, e.g. metering. | | | |
| **Reduced financial rating of UK water companies** | Not formally assessed by SEW. | Not formally assessed by SEW. | Climate change and the vulnerability of companies to its effects may become a measure by which companies' credit ratings are assessed and which may affect investor confidence and in turn the cost of capital. This impact is likely to be low for SEW as a regulated company. | Monitor | N/A | Monitor |
| **Greater OPEX reflecting additional impacts of climate change** | Not formally assessed by SEW. | Not formally assessed by SEW. | Higher operational costs as a result of the impacts listed here. | N/A | N/A | During PR14 preparation |

# 7. Barriers to implementing adaptation programme

*What are the main barriers to implementing adaptive action?*

The list below highlights the types of barriers that may currently stand in the way of successful adaptation...

- **Regulatory:** different pressures imposed by different water industry regulators result in companies needing to develop options that meet opposing objectives, e.g. Ofwat: least cost outcome; EA: best environmental outcome. Although the regulatory framework has a long-term view (25 years ahead), there is no unified approach through which adaptation to the long-term risks of climate change can be implemented.
- **Financial:** some adaptation options, e.g. increased winter storage capacity, effluent re-use, desalination, etc, may have significant short/medium-term financial consequences, but position the Company to meet long-term needs. Inevitably with large investment, there will be increased scrutiny of the need; therefore where climate change is a major driver, risk and uncertainty will need to be balanced appropriately. However, where a need has been identified based on current drivers, e.g. a supply-demand deficit including moderate climate change impacts, climate change adds weight to the evidence of need.
- **Environmental constraints:** e.g. designated conservation areas, which may limit the extent of new development relating to water resources or water treatment works not just identified in adaptation plans but in all plans. SEW will look for options that will provide, where feasible, a net environmental gain to ensure it achieves support.
- **Technical:** issues such as knowledge of impacts, and the ability to apply climate information to company-specific assets and circumstances.
- **Socio-political:** there may be resistance to some supply-side measures if they require large amounts of construction; similarly demand management in the form of metering and tariff setting will raise issues of affordability that will need to be addressed. This emphasises the need for a balanced assessment of drivers and risk so that customers, investors and regulators can see a clear case for action/investment that weighs up current and future need.
- **Competition:** the advent of competition may make inter-company cooperation more difficult/complicated in the case of shared resources and joint schemes.

The barriers identified will assist in formulating appropriate steps necessary for successful promotion of preferred options. For example, there may be preparatory or investigation work necessary before an option can be implemented. This will then be reflected in the implementation section of Task 3; the proposed first step for an option will reflect that there may be several different stages to implementation, and these may involve overcoming barriers before substantial progress can be made.

*Has the process of doing this assessment helped you identify any barriers to adaptation that do not lie under your control?*

Many of the barriers described are not in the direct control of SEW, and for others the Company will have only limited influence. Where a barrier involves regulation, either at regulator or government level, the Company will only have a limited ability to influence how policy may change. Many of the technical challenges could be addressed in-house; however, other resources the Company uses – for example, UK projections of climate change – are dependent on other organisations, and therefore SEW cannot always control the speed with which technical development is made.

SEW is also aware of potential impacts of climate change 'upstream' of its operations, i.e. in the supply chain. It is expected that climate change may have an impact both on the availability of resources such as power and chemicals, which SEW will incorporate into its adaptation plan.

Dialogue with regulators and other stakeholders through existing channels (e.g. SEA, water resources and business planning, procurement processes etc.) form a strong part of SEW's adaptation plan for all options,

in addition to the Company's communications strategy. In this way, knock-on impacts (both of SEW's actions on others, and of others' actions on SEW) can be identified, reduced and/or removed where appropriate.

For more information, see **Section 4** and **Appendix C** of the main report.

# 8. Report and review

*How will the outcome of the adaptation programme be monitored and evaluated and what is the timetable for this?*

Many of the adaptation actions proposed by SEW are investigative or monitoring activities. The majority of these are undertaken and reviewed routinely by the Company as part of its operational strategy or reviewed to form the basis of decision-making as part of the Company's Business Planning or Water Resources Management Planning processes in the run up to Periodic Reviews.

The nature of these proposed activities reflects the Company's awareness of the importance of the next 2-3 years for ensuring that information is available or reviews are carried out to inform investment proposals at the next Periodic Review, PR14. To obtain funding for climate change investment in the meantime, before PR14, the Company would need to utilise Ofwat's notified item process. In light of the time required to build up a supporting evidence base, PR14 will be the next critical milestone for enabling the Company to move forward with climate change adaptation investment proposals. At present, as illustrated in this report, the Company's focus is on ensuring that it is as prepared as possible at PR14 to make informed investment decisions.

Increasing awareness of climate change and moving towards increased data availability to inform climate change impact assessments will ensure that over time, climate change is increasingly accounted for in the Company's investment decisions. It is expected that over time, as a result of these actions, the headroom allowance in its WRMP for uncertainty over the impacts of climate change will reduce.

*How do you propose to monitor the thresholds above which impacts will pose a threat to your organisation (including the likelihood of these thresholds being exceeded and the scale of the potential impact)?*

Over time it is expected that the results of SEW's own and industry-wide research into climate change impacts will provide detail that is currently lacking on the sensitivity of certain receptors to climate variables; this in turn will assist in identifying thresholds above which receptor sensitivity changes. To-date, in many instances, particular thresholds have not been calculated by the Company as they require very specific quantitative assessments. In addition to industry-wide research where applicable, the Company's adaptation plan proposes that quantitative assessments be carried out, where supporting data is available, as part of preparatory work at PR14. Further to such assessments, any thresholds identified will be highlighted in the next iteration of the Company's climate change risk assessment.

*How will the benefits of the programme be realised and how will this feed into the next risk assessment and options appraisal?*

The benefits of the adaptation plan will be realised through integration with existing activities and plans. In particularly they will feed into the next set of regulatory plans, which incorporate risk assessments and options appraisal processes.

*How have you incorporated flexibility into your approach?*

The Company's climate change adaptation strategy leading up to PR14 is designed to allow informed investment decisions to be made, whilst ensuring that flexibility remains central to its decision making around

potential climate change implications. This strategy is underpinned by use of an adaptive management approach, whereby ongoing activities are incrementally adjusted to account for the impact of climate change, whilst monitoring impacts and adaptations to identify further need for action.

As part of its adaptive management approach, SEW has incorporated into its appraisal of adaptation options a qualitative estimate of potential regret. This considers the ease and cost of reversing the adaptation measure once it has been put in place, the uncertainty of its success, and any wider benefits the option may have. This measure of flexibility was taken into account in the selection of options for the Company's adaptation plan.

In its adaptation plan, SEW emphasises the importance of partnerships with other water companies, water industry regulators and local delivery partners in informing climate change impact assessments, contributing towards flexible approaches to adaptation, and overcoming barriers to adaptation.

For more information, see **Section 5** of the main report.

## 9. Recognising opportunities

*What opportunities due to the effects of climate change and which the organisation can exploit have been identified?*

Three particular opportunities were identified, as follows:

- Increase in winter rainfall: the likely increases in winter rainfall provide an opportunity for increased recharge and storage, bringing benefits for both ground and surface water sources. The need to manage this opportunity through appropriate adaptation options will be explored in preparing the next WRMP.
- Warmer annual average temperature: higher temperatures will speed up chemical and biological treatment processes for water and provide a potential benefit for treatment costs.
- Milder winters: milder conditions in winter have the potential to decrease in freeze-thaw damage to pipes and assets, thus reducing leakage and the frequency of burst pipes. Modelling studies indicate that under a 'Mid' climate change scenario, frost days could decrease by up to 10 days per year by the 2020s. This opportunity does not need a particular adaptation option for SEW to benefits; however, the focus of leakage loss can move to issues with heave, which may increase under climate change.

For more information, see **Section 3** and **Appendix B** of the main report.

## 10. Further comments

*Do you have any further information or comments which would inform Defra (e.g. feedback on the process, the statutory guidance, evidence availability, issues when implementing adaptation programmes, challenges, etc)?*

# 1. Introduction

## 1.1 Background

Activity relating to climate change to-date in the water sector and indeed across other sectors has traditionally focused on two areas: assessing potential impacts related to potential future climates; and developing mitigation measures, i.e. ways in which greenhouse emissions can be minimised. The realisation that mitigation alone will be insufficient to overcome the risks presented by climate change has resulted in a call for a greater focus on adaptation.

Adaptation involves preparing for and responding to the unavoidable consequences of climate change (such as higher temperatures, changing rainfall patterns, altered seasons and more extreme weather events). Adaptation is also sometimes, rather confusingly, referred to as 'risk mitigation'; however, the term adaptation will be used in this report. Responses could include changes to the planning and operation of fundamental business activities but could also extend to behavioural change and is something that all sectors of the economy and society will need to address.

The Adaptation Sub-Committee of the Committee on Climate Change has identified five adaptation priorities for the UK:

- land use planning;
- providing national infrastructure;
- designing and renovating buildings;
- managing natural resources; and
- emergency planning.

Water companies play a central role in three of these five priorities (providing national water and wastewater infrastructure, managing water - a natural resource, and emergency planning for example in times of drought). Therefore South East Water (SEW) and other water companies have a responsibility to society, as well as to their shareholders, to ensure that adaptation measures are considered, integrated into planning processes and decisions and implemented where appropriate.

It is acknowledged that there are limits to the level of climate change to which human and natural systems can adapt. Furthermore, costs of adaptation are likely to increase dramatically as significantly higher temperatures and larger rainfall extremes are experienced. Early consideration of adaptation options should therefore be designed wherever possible to allow options for adaptation in the future to be kept open.

## 1.2 Legislation

### 1.2.1 Adaptation reporting

The Climate Change Act 2008 gives the Secretary of State the power to direct 'reporting authorities', including bodies with functions of a public nature and statutory undertakers, to produce reports on their progress towards adaptation.

As a statutory water undertaker, South East Water (SEW) is one of a number of 'priority reporting authorities' who have been directed by Defra to report on the impacts to its functions presented by climate change and its plans for adapting to those impacts (see Appendix A for letter from Defra). Along with the letter to Regulatory Directors, Defra has issued Statutory Guidance (2009) to reporting authorities. The guidance sets out the broad approach authorities should take to

reporting; however, the content, volume and extent of supporting evidence required are not prescribed in detail. Water UK has interpreted the requirement as a high level report, drawing on existing assessment and reporting such as that undertaken for Water Resources Management Plans (WRMP) and in support of Strategic Business Plans (SBP) (Water UK, 2007).

To complement the Defra guidance, the Environment Agency (EA) has issued more detailed Supplementary Guidance (2009) to support authorities in reporting on the areas of flooding, coastal change and water resources.

Authorities are required to report to Defra by 31st January 2011. The reports will then be evaluated by Cranfield University against the statutory guidance and commented on by Defra and lead Government Departments. The Company should expect to receive comments back by April 2011, and it is expected that full reports from all Reporting Authorities should be published on the Defra website by the end of 2011.

### 1.2.2 Existing reporting frameworks that incorporate climate change

Key legislation under which water companies are already required to consider climate change, which could provide mechanisms under which water companies may propose adaptation measures, or which require companies to take account of the potential impacts of climate change in order to maintain compliance with the legislation include:

- The Environmental Assessment of Plans and Programmes Regulations 2004;
- The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999;
- Water resources planning under Section 37 A to D of the Water Industry Act 1991, as amended by Section 62 of the Water Act 2003;
- Drought planning under Section 39B of the Water Industry Act 1991, as introduced by Section 63 of the Water Act 2003 since the frequency and severity of drought events might be impacted by climate change;
- The Security and Emergency Measures (Water and Sewerage Undertakers) Direction 1998, under the Water Industry Act 1991 as companies are required to ensure the provision of essential water supply at all times, despite interruptions arising from weather events;
- The Reservoirs Act 1975; and
- The Flood and Water Management Act 2010.

The extent to which SEW has reported on adaptation measures under the above legislation will be discussed later in this report.

## 1.3 Adaptation across the UK water industry

The impacts of climate change on the water industry and potential adaptation options have been under consideration for a number of years, at both industry and company level. For most water companies, climate change is identified as a key pressure in their Strategic Direction Statement, particularly with regard to availability of water resources, flood risk to assets, decreasing water quality, and increasing surface run-off from heavy rainfall events. Water companies are required to take climate change into account in water resource planning – for example, in calculation of headroom – but at present any major investment decisions based that are primarily driven by climate change impacts are not funded by the regulator (Ofwat, 2008).

In a comprehensive survey of water company actions, the UKWIR CL01 project, *Climate Change – A programme of research for the UK water industry*, found that most companies had stated their intention to take action to adapt to climate change, with the majority at the stage of planning and assessing potential adaptation options (Arkell *et al*., 2008). Common responses across water companies included increasing water storage, desalination, and exploring conjunctive use of ground and surface sources (ibid). The report also identified that the focus for water companies – and, indeed, for much of UK industry as a whole – has been mitigation rather than adaptation (ibid). This was identified as primarily as a result of the relative abundance of legislation to mitigate greenhouse gas emissions compared to that of adaptation, with many companies naming a specific staff member responsible for carbon reduction. However, the report also concluded that most companies had realised the importance of mainstreaming adaptation into all parts of the business and that is was beginning to be adopted by all departments (ibid).

The impacts of climate change on water availability are likely to be felt mostly keenly by water companies in southern and eastern areas of the England (see Section 3.1 for more details). The inherent dependence of the water sector on climate therefore means that companies such as SEW are likely, relative to other sectors, to already have a good awareness of the potential impacts of climate change on their operations, as water availability is a business critical issue.

Although the principal risks to SEW will be related to water resources, supply and demand, this report will also consider the potential risks and adaptation requirements across all of its functions and activities, encompassing:

- Business continuity plans, Security and Emergency Measures Direction (SEMD) etc.;
- Risks to physical assets;
- Regulatory risks e.g. compliance, environmental standards, potential loss of authorisations etc.;
- Operation and management of buildings;
- Impacts on staff;
- Services: resources, treatment and supplies;
- Impacts on interest groups and investors;
- Customer risks;
- Supplier risks; and
- Interdependencies on other services e.g. energy, telecoms, financing etc.

### 1.3.1 Regulatory adaptation

The water sector in England is a regulated industry, subject to stringent operational guidelines and compliance metrics set by both the Water Services Regulation Authority (Ofwat), the Drinking Water Inspectorate (DWI) and the EA under Defra's direction. This means that water companies are often required to demonstrate consistency with other companies in their means of assessment of issues such as climate change.

Policy and legislative frameworks will need to allow water companies the flexibility to propose adaptation measures applicable to their individual circumstances. For example, facilitating the trialling and setting of tariffs to encourage water saving and providing unequivocal support for universal metering and water efficiency schemes in the price review.

Whilst the level of adaptive capacity in the water sector is arguably high (climate change has been included in three Periodic Reviews in England and Wales and the main issues are well understood by water providers, regulators and environmental NGOs), the present regulatory regime could be considered to lack direction and consistency around adaptation measures. In

the short term, this may be due to the need to consider additional complexities, such as competition, affordability, carbon reduction commitments and European environmental legislation, all of which will have a significant influence on climate change adaptation. However, in order for water companies to embrace climate change as part of their core business operations, the EA, Ofwat and the DWI must provide a coordinated voice regarding their expectations.

The focus of regulators to-date has been on assessment rather than strategy and measures. Indeed, excluding some resilience schemes, Ofwat has not supported any climate change related investment to-date. At the 2009 Periodic Review (PR09), most companies assessed climate change impacts based on the UK Climate Impacts Programme 2002 (UKCIP02) scenarios. The publication date of the 2009 UK Climate Projections (UKCP09) meant companies were not able to assess the full implications of the latest scenarios on their investment proposals. Ofwat therefore took the approach that no significant investment attributable to climate change would be funded at PR09; instead Ofwat has encouraged companies to use its Change Protocol to seek either an 'Interim Determination of K' or a 'log up/log down' to vary their price limits between PR09 and PR14. Variations will only be considered, however, if the investment sought is 'financially significant', i.e. at a net present value of +/-2% of turnover in the previous financial year, and if it is accompanied by "robust and clear evidence" of the cost implications. At present the required level of evidence and the treatment of UKCP09 are unclear, although work is underway to address the latter

## 1.4 Aim and objectives of this report

To ensure SEW complies with the Climate Change Act and is consistent with the approach outlined in the Defra guidance, the aim of this report is to provide a rigorous and well evidenced risk-based approach to adaptation reporting for SEW. The objectives of the report are to assess SEW's business risk management procedures in terms whether they are:

- Documented;
- Evidenced;
- Justified; and
- Repeatable.

The report will also individually assess and then combine the 'likelihood of the occurrence of the impacts' with an assessment of the 'severity of the impact', whilst also expressing where accountability lies.

The detailed approach taken to meet the above aim and objectives is documented in the following section. Overall, this report aims to provide the necessary level of detail and rigour anticipated by Defra, providing an appropriate level of evidence and referencing supporting technical assessments.

## 1.5 Approach

This report follows the main stages of reporting set out in the Defra guidance:

- Assessing risks, identifying threats and opportunities;
- Developing adaptation plans; and
- Implementation and monitoring.

These three stages are expanded upon in the following sections of the report.

# 2. South East Water

## 2.1 Overview of South East Water's functions

South East Water (SEW) is a 'Water Only Company' operating within the UK regulated water sector. Under the regulations that govern all English and Welsh water companies, SEW is required to comply with its instrument of appointment (licence) set out by Defra; the requirements of Ofwat, the economic regulator of the water and sewerage sector; and water quality regulations enforced by the DWI.

SEW is a private limited company, owned by Caisse de dépôt et placement du Québec (CDPQ) and the unlisted Utilities Trust of Australia (UTA). CDPQ is one of the largest institutional fund managers in Canada and North America, managing investments worth around £130 billion, and is a shareholder in more than 4,000 companies worldwide, including BAA, the UK's leading airport operator. UTA is an open-ended trust owned, in the main, by a number of Australian superannuation funds.

SEW supplies drinking water treated to the highest UK and European standards to over two million people in nearly 900,000 properties. SEW operates 24 hours a day, 365 days of the year. The majority (70%) of SEW's water supply is abstracted from more than 250 groundwater boreholes, with the remainder from six river intakes and six surface water reservoirs. As such, the Company has a reasonable diversity of sources, from which water is treated and pumped around its supply area through a distribution network of more than 14,500km of underground pipes.

As shown in Figure 2.1, the SEW supply area is split into an eastern and a western region, each comprising distinct 'Water Resource Zones'. Parts of Kent, East Sussex and West Sussex constitute the eastern region, with the western region extending through parts of Hampshire, Surrey and Berkshire.

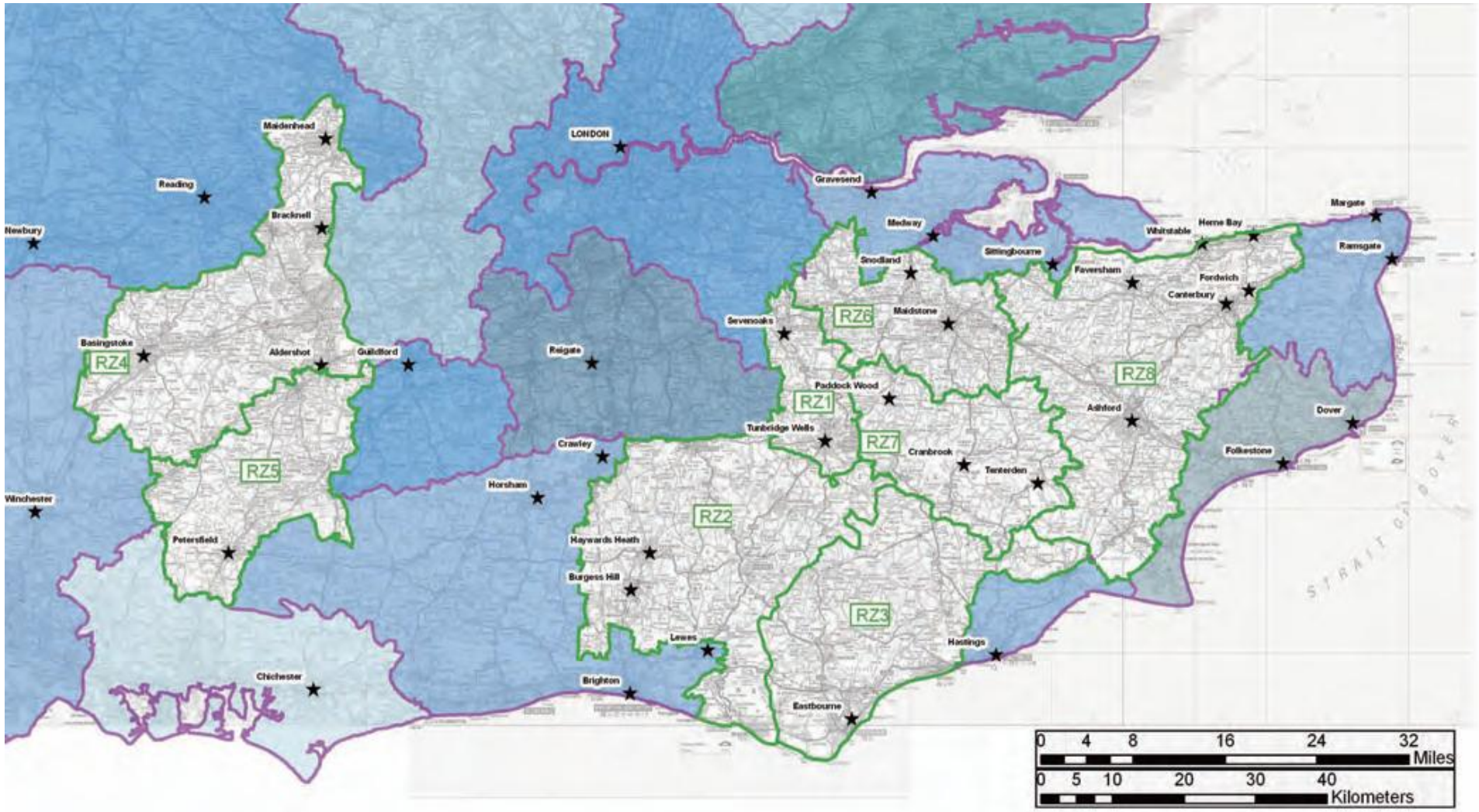


**Figure 2.1 - Map of South East Water supply area Source: SEW Revised Draft WRMP 2010)**

## 2.2 Pressures on South East Water

The SEW area contains some of England's most environmentally important habitats, and the Company itself manages 20 Sites of Special Scientific Interest (SSSIs), a National Reserve, two local Nature Reserves and numerous Areas of Outstanding Natural Beauty. Customer research carried out by SEW has shown that maintaining river health and raw water quality is seen as the core environmental responsibility of the Company. The Company, as a landowner and a statutory water undertaker, has multiple environmental responsibilities, perhaps the most significant of which is the need to ensure 'no deterioration' to any water bodies under the EU Water Framework Directive. This relates both water quantity and water quality (chemical and biological).

SEW operates in south east England, a region classified by the EA as being under 'serious water stress'. This means the region experiences comparatively low rainfall, comparatively high levels of planned population growth, high per capita water consumption, all combined with abstraction at levels potentially above the sustainable level in some areas. The classification illustrates some of the additional pressures facing SEW due to its location. The implications are that it must not only fulfil its statutory duty to promote water efficiency, but must meet more stringent water efficiency standards than companies in other regions of England and Wales. Furthermore the Company is likely to be exposed to the potential effects of climate change in terms of water scarcity more acutely than other areas of the country. This may result in increased environmental fragility and vulnerability to abstraction regimes to which SEW will need to respond, as well as increased need for SEW's assets to be operable under low flow and/or highly variable weather conditions.

In summary, SEW's core functions encompass a balance between its ability to physically abstract, treat and distribute water, the needs of its customers, the requirements of the regulators and protection of the environment.

As mentioned previously, water companies arguably already have a relatively high level of adaptive capacity for managing the impacts of climate change. SEW's level of preparedness is described in the following section.

### 2.2.1 Business preparedness before Direction to report was issued

SEW undertakes strategic planning and operates in line with the UK water sector's well developed framework for business planning, water resources planning and drought management. As part of this, SEW has forecast its supply and demand for the next 25 year period, and prepared detailed investment proposals to maintain quality, resilience and quantity of water for the next 5 years as part of its Business Planning process. Some quantification of the potential risk to these from climate change has been considered but the Company acknowledges there is additional work to be done both to identify and where possible quantify the risks, and then to adapt. In its Strategic Direction Statement, SEW places as one of its top long term priorities with respect to water quality "meeting all our legal obligations and preparing for climate change impact."

SEW's operational sensitivity and business preparedness to climate is exemplified in its response to the most recent drought: between November 2004 and February 2007. Consecutive dry winters representing the driest period since records began in 1883 resulted in the Company imposing a hosepipe restriction on its customers. However, the Company's efforts to reduce the impact of the drought in accordance with its Drought Plan (including increased leakage detection activity and working with customers to demonstrate how they could save water during the drought) resulted in the continued delivery of a high level of operational service to its customers characterised by, amongst others, the following achievements:

- Maintaining leakage below the 'economic level';
- Maintaining treatment works, reservoirs and the pipe network in a stable condition; and

- Keeping supply interruptions to within the target level.

SEW therefore has demonstrated a level of preparedness for a drought event of this type and magnitude. As drought may become more prevalent under a future climate, this will stand the Company in good stead for building upon its existing contingency plan.

#### 2.2.1.1 Summary of SEW's business preparedness

Being prepared for climate change can be considered to comprise four elements, as described in Figure 2.2.

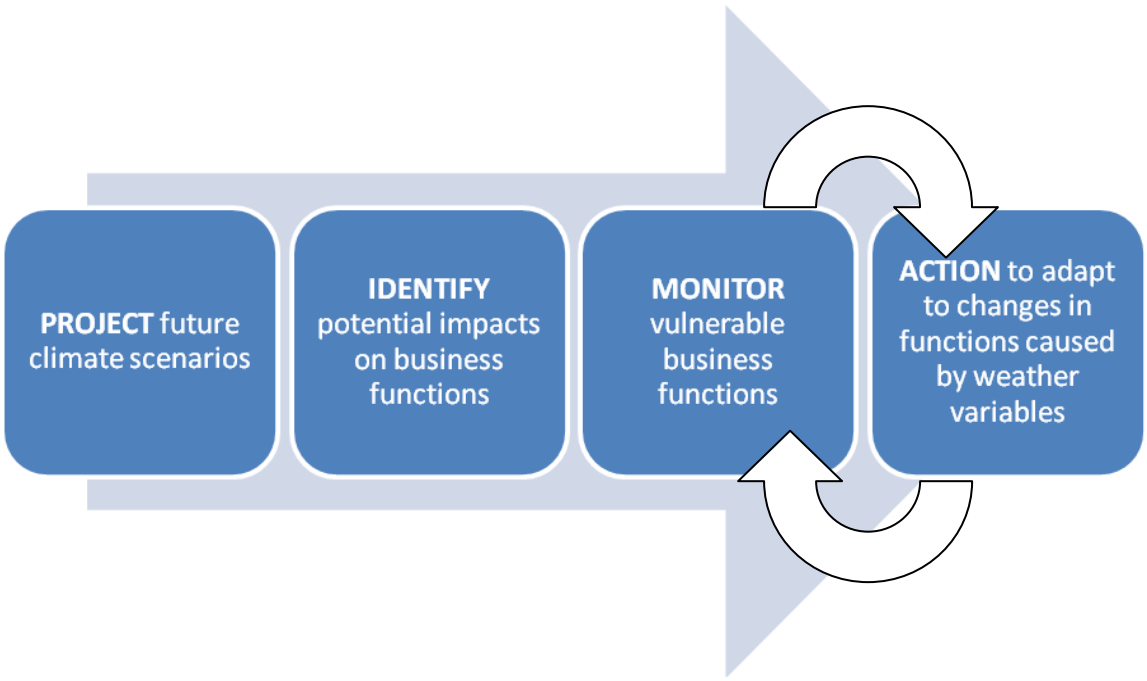


**Figure 2.2 - Elements of business preparedness to climate change impacts**

As part of its normal operations, SEW employs extensive monitoring and sampling procedures, across water resources, water quality, customer services, and asset management. The Company is therefore reasonably well prepared to achieve this component of adaptation. However, SEW has undertaken limited forecasting of future climate scenarios, nor has it extensively modelled correlations between operations and weather variables, meaning that the first two steps shown in Figure 2.2 are where the Company should firstly focus its efforts, before it can react and adapt to climate change.

# 3. Assessing risks, identifying threats and opportunities

This section provides a summary of the potential climate to which south east England might be exposed in future (Section 3.1), a description of the methodology used to identify impacts (Section 3.2) and a review of the impacts that were identified for SEW's business functions, services and stakeholders (Section 3.3).

## 3.1 Climate change in south east England

This section highlights the key future climate changes for the south east according to the latest UK climate change projections (UKCP09). Though this is not an exhaustive list of the likely climate changes, it provides the context for the impacts identified in the subsequent sections.

In summary, the south east of England will experience hotter, drier summers with increasing likelihood of heatwaves and dry spells, such as the summer of 2003. The central estimate of mean temperatures is of a 2.8°C rise by the 2050s under Medium emissions, with a corresponding reduction in rainfall of up to 19 percent, putting pressure on water resources through both reducing supply and increasing demand. Winters are likely to become milder and wetter, with more rain falling in heavy events. Both mean rainfall and heavy rainfall are predicted to increase by 16 percent by the 2050s under Medium emissions, resulting in both the potential for increased water storage and the increased risk of flooding to assets. Sea level rise at the northern and southern extent of SEW's jurisdiction is likely to by between 17 and 55cm by the end of the century under Medium emissions, putting coastal assets and sources at risk from flooding and saline intrusion respectively.

**A note on the projections**

The projections from UKCP09 have probabilities associated with them. A 'central estimate' or '50$^{th}$ percentile' refers to a median projection – i.e. it is as likely as not to be exceeded. The 90$^{th}$ and 10$^{th}$ percentiles (or 95$^{th}$ and 5$^{th}$ for sea level rise projections) are used to represent upper and lower bounds of that climate change projection; these can be viewed in simple terms as 'very unlikely to be greater than' and 'very unlikely to be less than' respectively.

The maps refer to the central estimate for the Low, Medium and High emissions scenarios for the 2050s only. The plume plots show how the climate is likely to change over the 21$^{st}$ Century, and show the spread of percentiles (from 10$^{th}$ to 90$^{th}$) for the Medium emissions scenario. All land-based results presented refer to the south east administrative region.

All figures quoted in the following text relate to the medium emissions scenario: the central estimates (50th percentile) are used, with a range given in brackets (10th to 90th percentile).

### 3.1.1 Temperature

While climate change is likely to cause increase in year-round temperatures, these are most pronounced in summer. The south east of England is projected to experience some of the largest increases in temperature for the UK, with mean summer temperatures projected to increase by 1.6°C (0.6 to 2.7°C) by the 2020s, 2.8°C (1.3 to 4.6°C) by the 2050s, and 3.9°C (2.0 to 6.5°C) by the 2080s (see Figure 3.1). Increases are largest towards the south and west of the region (see Figure 3.2). The region will also experience increases in maximum daily temperatures and increasing likelihood of extreme temperatures and heatwaves.

Climate change will result in milder winters, with decreasing likelihood of very cold spells and snowfall – though these will still occur. Mean temperature changes show increases of 1.3°C (0.6

to 2.2°C) by the 2020s, 1.7°C (0.7 to 2.9°C) by the 2050s, and 3.0°C (1.6 to 4.7°C) by the 2080s (see Figure 3.3). Increases are largest along the south coast (see Figure 3.4).

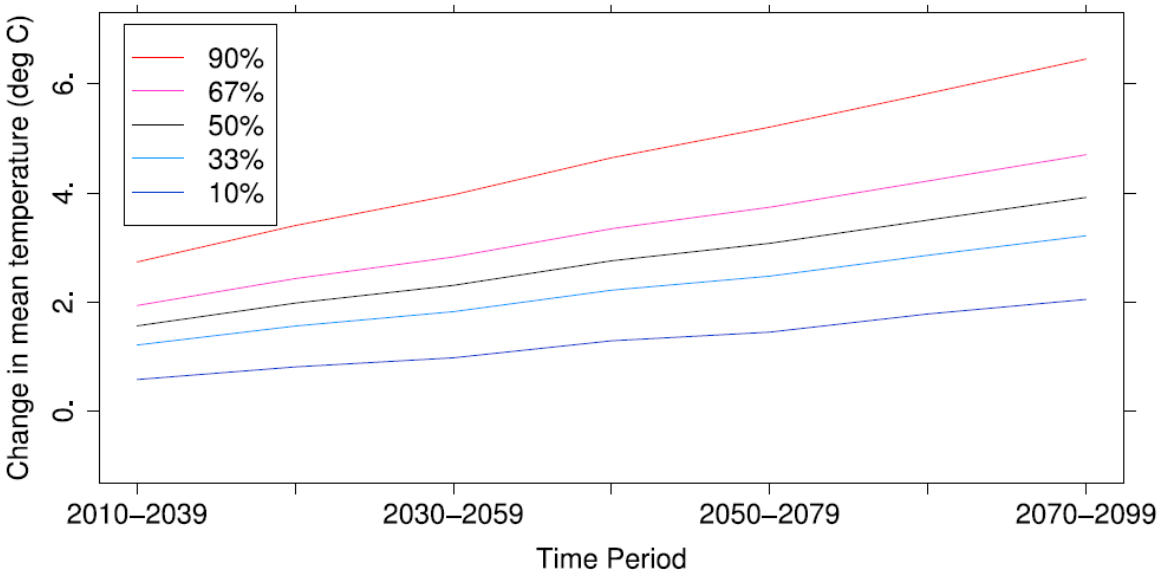


**Figure 3.1 – Plume plot of summer mean temperature changes in the South East region under Medium emissions © UK Climate Projection 2009**

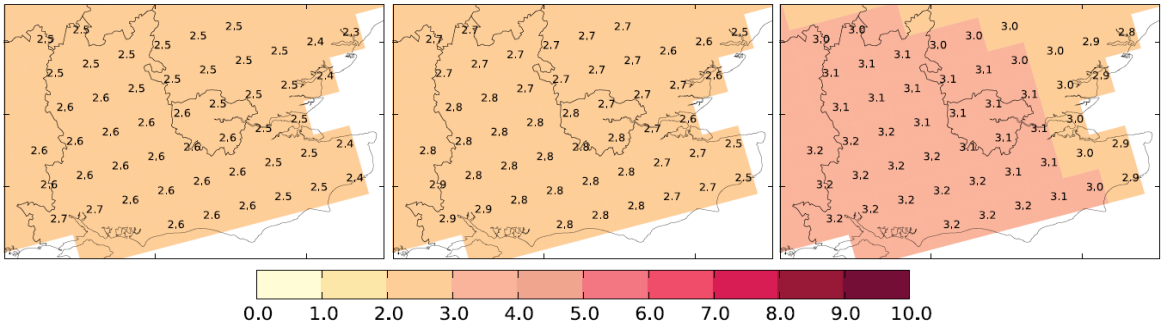


**Figure 3.2 – Central estimates (50th percentile) for changes in mean summer temperature for the South East region under Low emissions (left), Medium emissions (middle) and High emissions (right) © UK Climate Projection 2009**

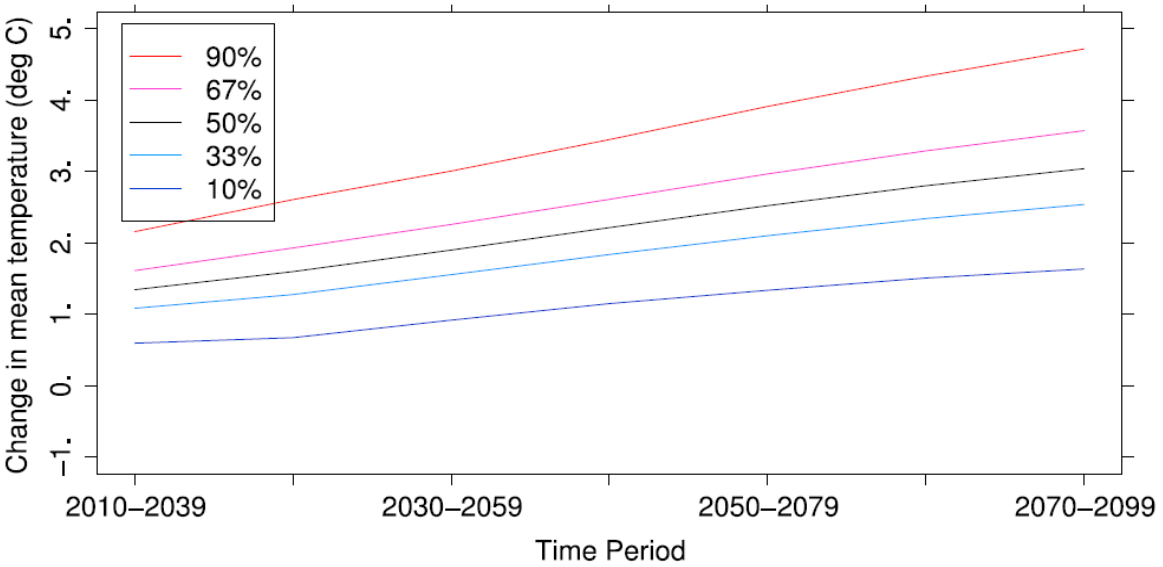


**Figure 3.3 – Plume plot of winter mean temperature changes in the South East region under Medium emissions © UK Climate Projection 2009**

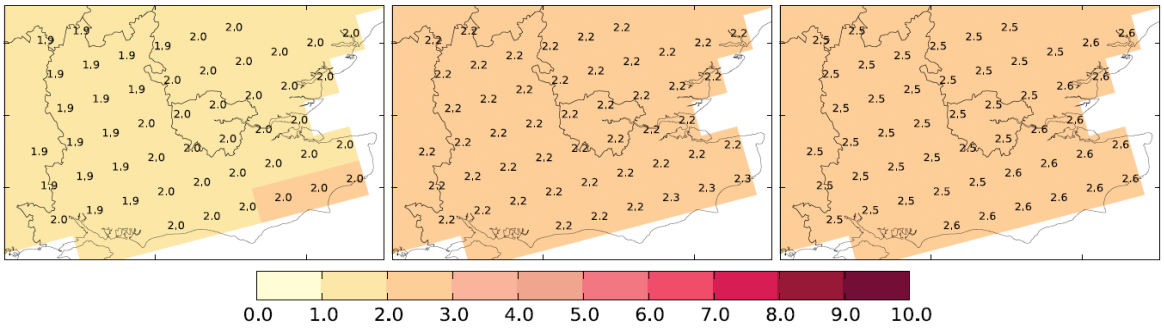


**Figure 3.4 – Central estimates (50th percentile) for changes in mean winter temperature for the South East region under Low emissions (left), Medium emissions (middle) and High emissions (right) © UK Climate Projection 2009**

## 3.1.2 Precipitation

On an annual basis, climate change is unlikely to have a substantial impact on precipitation totals; however, the changes in seasonal rainfall are likely to be much more pronounced, with decreases in summer rainfall counterbalanced by winter increases. Changes in the shoulder seasons of spring and autumn show small increases (<5% for central estimates under High emissions throughout the 21st century), which are insignificant compared to summer and winter changes.

Mean summer precipitation is projected to decrease by 8 percent (-26 to +14 percent) by the 2020s, 19 percent (-41 to +7 percent) by the 2050s, and 23 percent (-48 to +7 percent) by the 2080s (see Figure 3.5). For winter precipitation, projections show an increase of 6 percent (-4 to +19 percent) by the 2020s, 16 percent (+2 to +36 percent) by the 2050s, and 22 percent (+4 to +51 percent) by the 2080s (see Figure 3.6). For both seasons the changes are most substantial in the south west corner of the region (see Figure 3.7 and Figure 3.8).

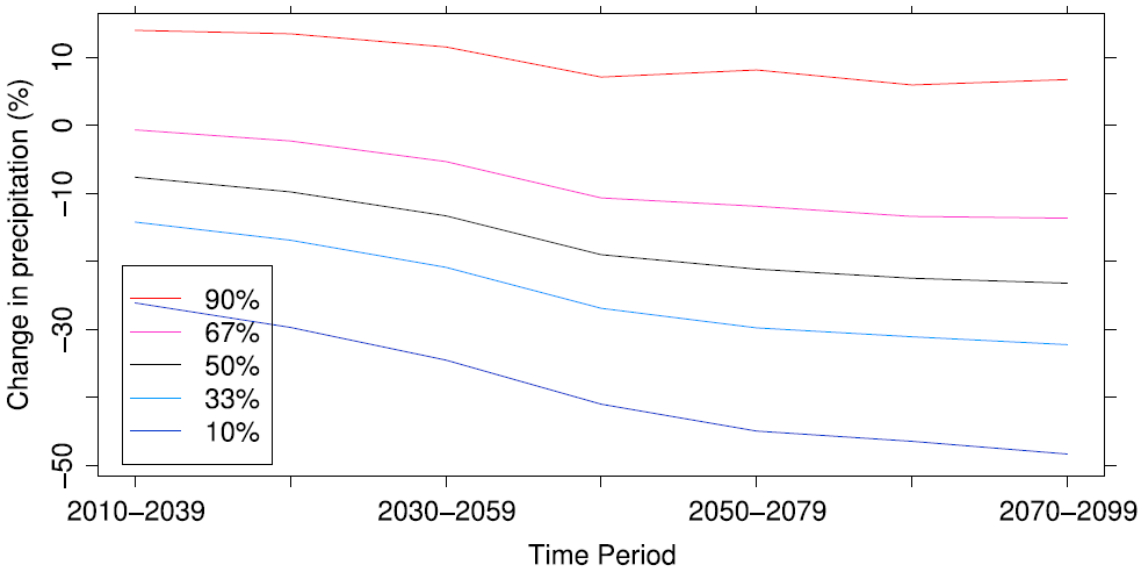


**Figure 3.5 – Plume plot of summer mean precipitation changes in the South East region under Medium emissions © UK Climate Projection 2009**

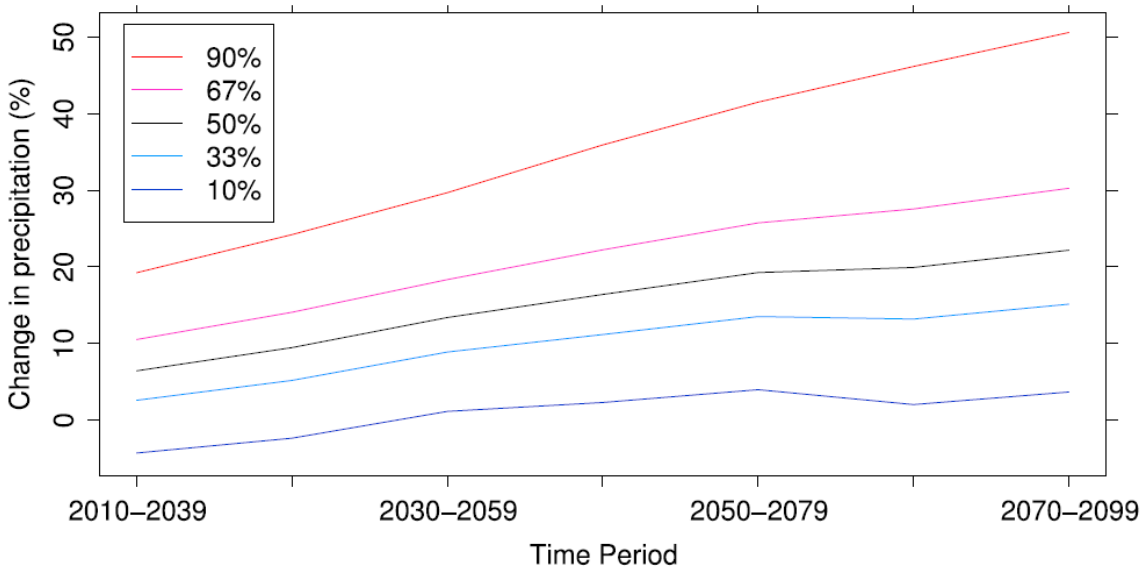


**Figure 3.6 – Plume plot of winter mean precipitation changes in the South East region under Medium emissions © UK Climate Projection 2009**

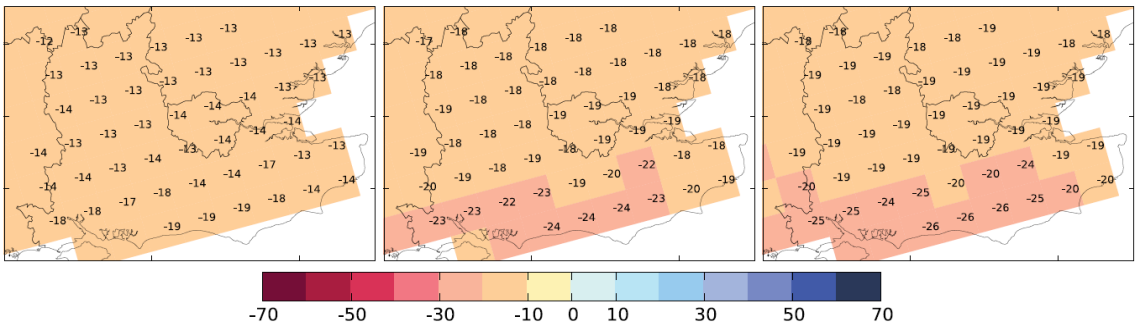


**Figure 3.7 – Central estimates (50th percentile) for changes in mean summer precipitation for the South East region under Low emissions (left), Medium emissions (middle) and High emissions (right) © UK Climate Projection 2009**

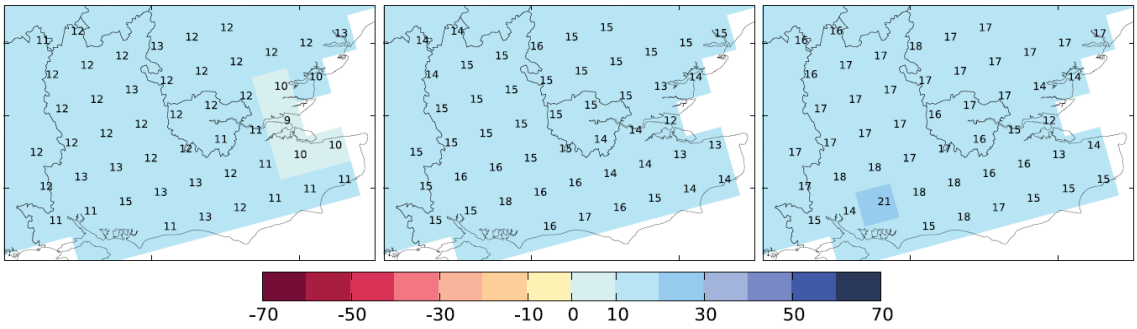


**Figure 3.8 – Central estimates (50th percentile) for changes in mean winter precipitation for the South East region under Low emissions (left), Medium emissions (middle) and High emissions (right) © UK Climate Projection 2009**

UKCP09 also provides a projection of the mean amount of precipitation on the 'wettest day' of a given season, which gives an indication of how heavy rainfall events are likely to change in the future. For the south east region, winter wettest day precipitation is projected to increase by 6 percent (-4 to +18 percent) by the 2020s, 16 percent (+3 to +33 percent) by the 2050s, and 23 percent (+7 to +45 percent) by the 2080s (See Figure 3.9). Increases are largest towards the centre of the region (see Figure 3.10).

It should be noted that UKCP09 projections do not include changes in localised convective storms, as these are not captured by the climate model on which UKCP09 is based. With hotter summer temperatures, particularly in the south east, localised convective rainfall could become increasingly prominent; therefore, UKCP09 may be underestimating rainfall totals and extremes for the areas in the Company's jurisdiction.

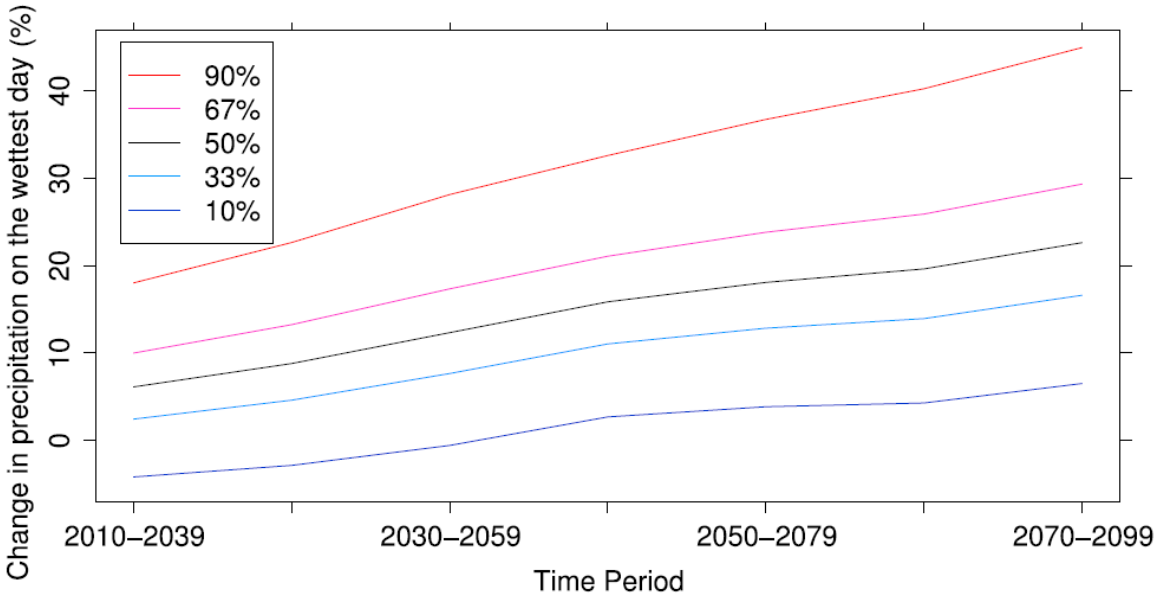


**Figure 3.9 – Plume plot of changes in winter wettest day rainfall in the South East region under Medium emissions © UK Climate Projection 2009**

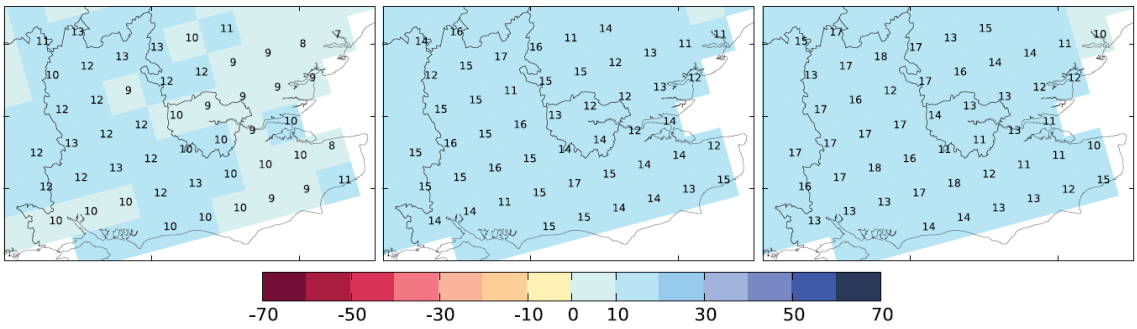


**Figure 3.10 – Central estimates (50th percentile) for changes in winter wettest day precipitation for the South East region under Low emissions (left), Medium emissions (middle) and High emissions (right) © UK Climate Projection 2009**

### 3.1.3 Sea level rise

UKCP09 includes projections for both relative and absolute sea level rise. Projections for relative sea level rise are presented here because they also take into account any movement in the land mass ('isostatic rebound'). Projections are very similar at both the northern (Whitstable) and southern (Eastbourne) coasts in South East Water's jurisdiction (see Figure 3.11 and Figure 3.12), with increases of 10cm (5 to 15cm) by 2020, 22cm (10 to 33cm) by 2050 and 36cm (17 to 55cm) by 2080 under Medium emissions.

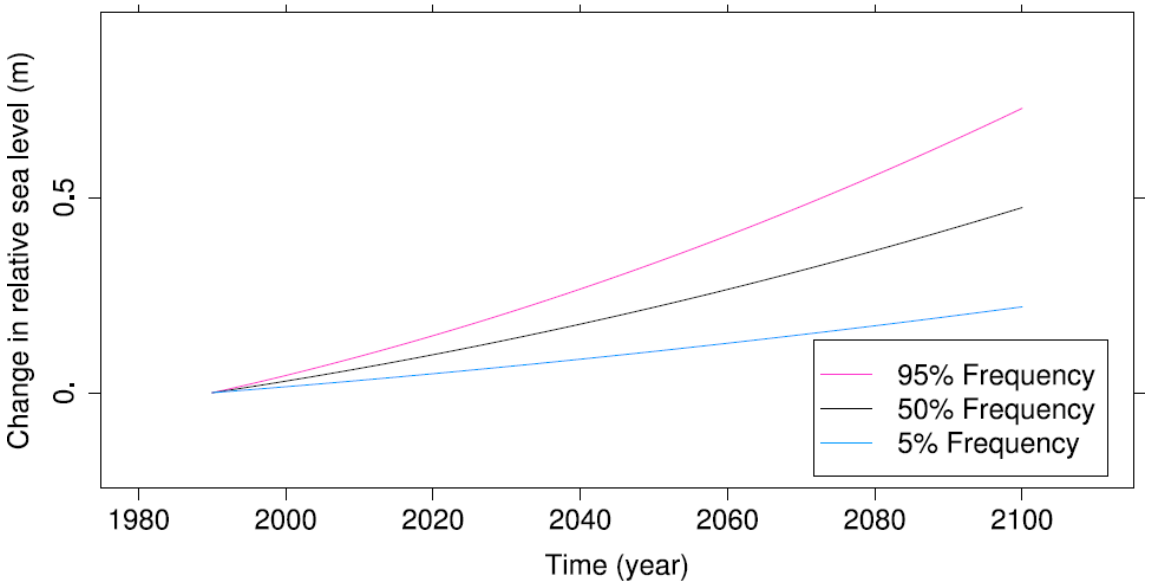


**Figure 3.11 – Plume plot for change in relative sea level rise through the 21st century for Whitstable. Plot shows three percentiles: 50th (black line), 95th (red line) and 5th (blue line) for the Medium emissions scenario. © UK Climate Projections 2009.**

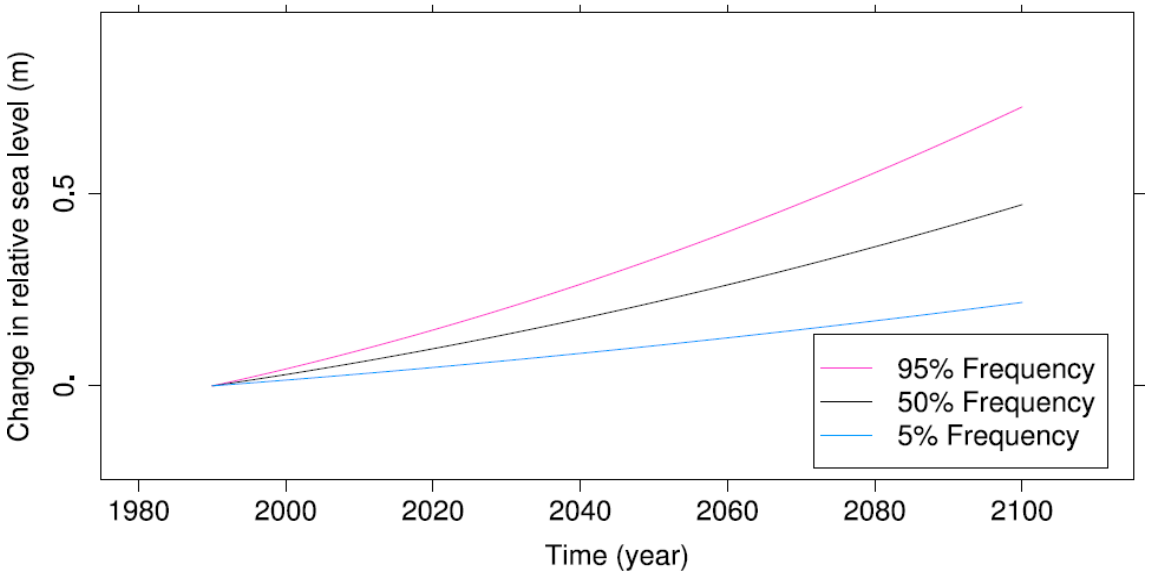


**Figure 3.12 – Plume plot for change in relative sea level rise through the 21st century for Eastbourne. Plot shows three percentiles: 50th (black line), 95th (red line) and 5th (blue line) for the Medium emissions scenario. © UK Climate Projections 2009.**

## 3.2 Approach to impact and risk assessment

Figure 3.13 below shows a flow diagram of the process taken to develop a full list of the potential impacts of climate change for South East Water.

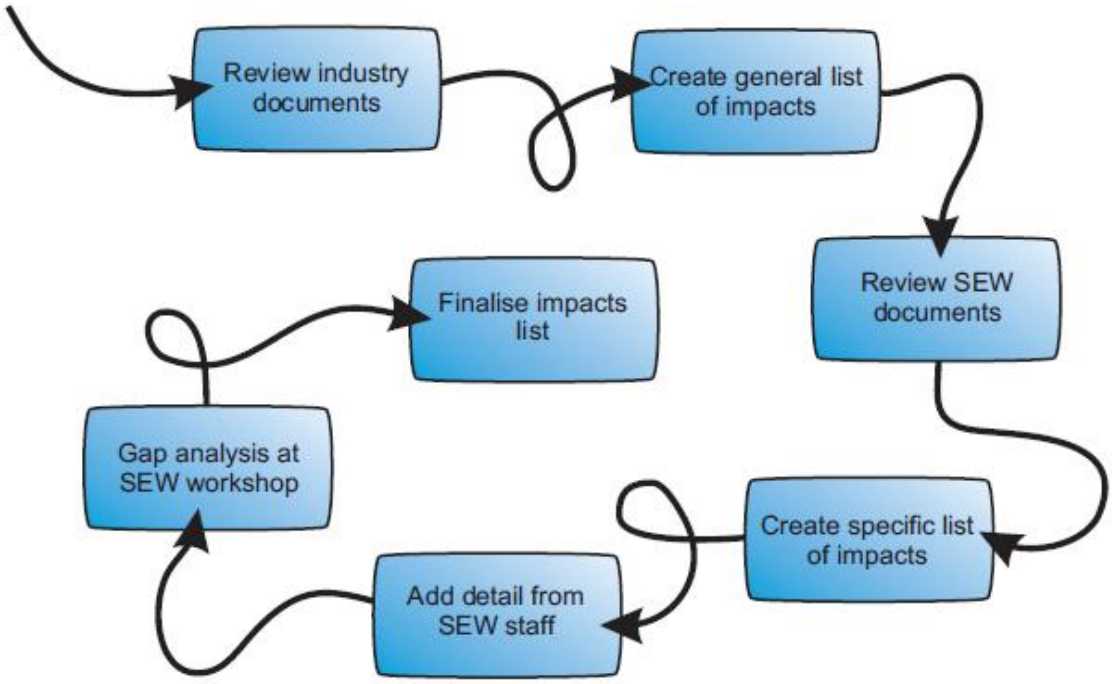


**Figure 3.13 – Flow diagram of development process for impacts list**

The first step in our approach collated information on general impacts from industry-wide research into climate change risks. Such research included the UKWIR CL01 research programme, the Water UK approach for adaptation in asset management, and the initial results from the UK Climate Change Risk Assessment that is currently being undertaken. A list of climate change impacts was compiled in an Excel spreadsheet, hereafter referred to as the matrix and presented in Appendix B, for which impacts were allocated between the following business functions:

- Water Resources;
- Asset Management;
- Water Quality;
- Energy and Carbon;
- Biodiversity and Conservation;
- Organisational Capacity;
- Facilities Management; and
- Finance and Investment.

Building on these generic areas of impact, specific climate change risks to SEW were identified drawing on a combination of internal and external documents. Appropriate personnel from each business function were consulted and any relevant documentation pertaining to the impacts identified; examples include (see References for full list):

- Water Resources Management Plan (and appendices);
- Business Plan;
- Asset Management Plans;
- Drought Plans;
- Flood Risk Assessments;
- Water Quality Plans;
- Security and Emergency Measures Direction (SEMD) and Resilience Reports;
- Strategic Direction Statement;
- Energy Plan; and
- SSSI Management Plans.

Each document was reviewed for any assessment or data in relation to climate change – quantitative or qualitative – that has been carried out by SEW or commissioned by the Company. A summary of the work was carried forward to the aforementioned matrix in addition to any quantitative information that was subsequently used by the Company in, for example, their Water Resources Management Plan. This includes any thresholds for impact – a specific input for the Defra summary reporting tables.

From the initial assessment, there were areas where climate change assessment work was not identified, so further information was gleaned from email and telephone conversations with appropriate experts within the Company. This gave a more comprehensive impacts list, despite formal assessment not always being available. The matrix contained a 'confidence' element, allowing a distinction to be made between the various sources of information and data.

Once the matrix was completed based on these initial sources, a gap analysis was undertaken at a workshop with SEW staff. The matrix was forwarded to the attendees in advance of the workshop, and they were asked to consider whether the gaps identified were genuine gaps or whether the appropriate information or reports had not been included. Where genuine gaps were found, the attendees were asked to consider whether each gap is specific to SEW or whether it is a gap for the water industry as a whole.

At the workshop a group discussion allowed attendees the opportunity to fill the gaps in both the impacts list and the list of information that had been reviewed. From this, a completed list of impacts was completed and the workshop was also used as an opportunity for the attendees to identify the most pressing risks for SEW's operations and stakeholders. This risk categorisation helps prioritise relevant adaptation options in the next stages of the project.

## 3.3 Identifying and quantifying climate risks on SEW functions

Following the approach outlined in Section 3.2, the impacts of climate change on SEW that were identified are summarised in Table 3.1; additional details are presented in Appendix 2.

In some cases secondary impacts may also occur; for example, where an increased risk to raw water quality is identified, secondary impacts may include an increase in the cost (financial, social and environmental) of treatment; or where a risk of a reduction in water availability is identified, secondary impacts may include the cost of developing new resources or undertaking demand management. Secondary impacts have not been described in detail in Table 3.1.

**Table 3.1 - Summary of climate change impacts on South East Water**

| Climate Change Impact | Description |
|---|---|
| **Water Resources** | |
| Reduction in surface water availability | Reductions in rainfall, particularly during consecutive seasons, with corresponding increases in year-round PET can reduce reservoir refill capability. Winter recharge is likely to increase, though how changes in interannual variability are more uncertain. Winter rainfall is also likely to occur increasingly in heavy events, changing the balance of infiltration and runoff. |
| Increased competition for and need to consider shared water resources | The Water Resources in the South East (WRSE) Group, driven by the EA, may require companies to work more closely in managing shared resources, e.g. the River Medway Scheme and Southern Water. Greater numbers of sustainability reductions may also be imposed. Climate change is likely to emphasise a much more integrated strategy across the region. |
| Risk of non-renewal of time limited licences or existing licences being modified | SEW operates in a water stressed area so there is already increasing scrutiny and risk to existing abstraction licences. This is likely to increase with a change in climate due to changes in hydrology. Increases in evapotranspiration and lower rainfall in summer periods will result in lower flows in rivers. Increases in rainfall intensity may result in flashier river flows, reducing the period of time available to exploit peak flows. Licences may need to be altered to maintain the balance between environmental needs and public water supply. |
| Increasing demand | Reductions in rainfall, particularly during consecutive seasons, will reduce the amount of groundwater recharge that occurs, hence decreasing the availability of groundwater resources to meet demand. |
| Reduction in groundwater availability | Reductions in rainfall, particularly during consecutive seasons, will reduce the amount of groundwater recharge that occurs, hence decreasing the availability of groundwater resources to meet demand. |
| **Asset Management** | |
| Increase in risk of fluvial flooding | Increased frequency of extreme rainfall events will heighten the risk of river levels rising and causing fluvial flooding of water company assets. |
| Increase in risk of groundwater flooding | Increased frequency of extreme rainfall events will heighten the risk of groundwater levels rising and causing flooding of both underground and above-ground water company assets. Flooding of service trenches will also inhibit the ability of SEW to repair leaks. |

| Climate Change Impact | Description |
|---|---|
| Increase in pluvial (surface water) flooding | Increased frequency of extreme rainfall events will heighten the risk of surface water flooding of water company assets, particularly in areas where SUDS are not present. Flooding will also reduce the mobility of SEW staff to access sites and detect and repair leaks in inundated areas. Risk of flooding exacerbated where development results in permeable surfaces are replaced with paved areas within catchments. |
| Increase in tidal flooding | Sea level rise may expose SEW assets to both erosion and flooding with saline water. Impacts will clearly be greater at coastal sites, but those situated on estuaries will also be vulnerable. Consideration of the risk of tidal flooding may also limit the favourability of particular resource options, e.g. desalination plants, in future options appraisals. |
| Risk to dam safety | This impact relates to the capacity of dam spillways to deal with high volumes of water from extreme rainfall events that could lead to dam overtopping and erosion of the embankment materials, leading to dam failure. The structural stability and therefore safety of dams is also vulnerable to extended periods of low rainfall, fluctuations in water level and extremes of temperature. The results of these climatic impacts, respectively, include desiccation of clay cores, increases in pore pressure leading to erosion, and thermal cracking. |
| Risk to structural stability of dams | Soil conditions may exhibit increasing variability as a result of changes in inter-annual temperature and rainfall regimes, which may affect slope and structural stability, as described above. |
| Increases in leakage / burst frequency | While low temperature extremes and snowfall are predicted to decrease – and thus reducing the risk of burst frequencies and leakage through freeze-thaw weathering, reducing soil moisture in dry spells will increase the risk of heave and associated damage to pipes. |
| Increase in sedimentation | Extreme rainfall events will cause increased runoff rates and increased sediment mobility, resulting in increased conveyance of fine sediment and also large sediment into reservoirs and rivers, causing siltation. |
| Asset deterioration through sediment settlement | Multi-season low rainfall events would reduce the frequency of flushing flows passing through catchments, resulting in potential siltation of intake structures, particularly on rivers. |
| Variable water quality affecting treatment processes | Greater variability in water quality as a result of both variable dilution potential associated with flow extremes and differing pollutants in raw water from altered land practices, may affect the efficacy of water treatment processes. Single-stage treatment processes will be particularly vulnerable to this. |
| Increase in outages from bad weather affecting assets and power supply | The frequency of outage events resulting from both extreme rainfall and low flow is likely to increase with climate change. Outages from more persistent environmental change and cumulative effects of causal factors can also lead to an increase in outage frequency. An increase in outage will impact SEW's supply-demand balance and the operation of sites. This may also impact upon SEW's DG3 'interruptions to supply' reporting, which is considered by the economic regulator, Ofwat. |
| Maintenance access difficulties in bad weather | Access to SEW sites for operations staff and delivery vehicles or the ability to operate leak detection and repair services may be inhibited by extreme rainfall and flooding. |
| **Water Quality** | |
| Saline intrusion | Rising sea levels may cause salinity of groundwater sources, thus making them inoperable, sometimes permanently. This impact is more likely to affect sources at/near the coast. |

| Climate Change Impact | Description |
|---|---|
| Risk of aquifer contamination from flooding | Extreme rainfall events and associated increases in groundwater flooding may result in conveyance of pollutants through groundwater into aquifers. Existing groundwater source treatment processes may become inadequate. |
| Increased agricultural runoff | Increased surface runoff, identified above as being a direct result of extreme rainfall events, will provide increasing capacity for agricultural fertilisers, pesticides, herbicides and nutrients to be conveyed to river channels and thus affecting quality of sources of raw water. |
| Increased algae risk in reservoirs | Lower summer flows, higher temperatures and increased solar incidence are likely to increase the risk of larger and more frequent algal blooms in reservoirs. This will heighten the need for treatment, thus increasing OPEX and potentially necessitating a capital solution. Some shallow water bodies may no longer be suitable for water extraction. |
| Reduction in water volumes and pollution dilution | Multi-season low rainfall and associated low flows in rivers, reservoirs and aquifers, would result in lower dilution potential for pollutants and consequently higher raw water concentrations entering treatment works. |
| Increased risk of cryptosporidium in reservoirs | Higher demands as a result of increased temperatures and lower summer rainfall will mean reservoirs are drawn down more rapidly. Low residence times can increase the risk of cryptosporidium in reservoirs, thus putting sources at risk. |
| Increased risk of turbidity | Extreme rainfall events can result in flashy river flow regimes. This in turn leads to greater disturbance of benthic sediment which, along with greater sediment conveyance from surface runoff, can cause increased turbidity risks at water treatment works. High turbidity levels often result in auto-shutdown of treatment works, thus impacting supply. |
| Nutrient and sediment loads to rivers | Extreme rainfall events (particularly after dry periods) will result in the mobilisation of large quantities of fine sediment. This will result in a heightened risk of siltation at intake structures and increased mobility into raw water of bound nutrients, potentially impacting treatment efficacy. |
| **Energy and Carbon** | |
| Increasing energy demand in warmer/drier weather | Demand for water increases in warm, dry weather, which increases treatment and pumping requirements and hence energy use. This has both financial and carbon implications. |
| **Biodiversity & Conservation** | |
| Increasingly difficult management and improvement of conservation areas | A changing climate is likely to alter the condition of conservation areas, thus management and preservation of baseline conditions will become increasingly difficult; a particular case would be the chalk grasslands habitat diminishing or disappearing. |
| Potential difficulty in meeting WFD standards | Climate change may make it more difficult to meet the new WFD standards for all water bodies to be in 'Good' ecological condition. |
| Potential change to abstraction licences to protect SSSIs and wetlands | Licensing conditions for abstractions may become stricter in order to protect European designated wetlands in supply areas. |
| Decrease in base flows in rivers | A decrease in river base flow in summer may result in the need for alterations in the operation of reservoirs to supply rivers with compensation flow (to maintain good ecological status in the basin). |

| Climate Change Impact | Description |
|---|---|
| **Organisational Capacity** | |
| Lack of staff awareness of climate change and associated impacts, adaptation options and mitigation requirements | The impact of climate change on operations is likely to impact all SEW staff in some way in the future, e.g. in operation of sites, access to sites or responding to customer enquiries or complaints. |
| Higher numbers of customer complaints | Greater frequencies of extreme events, such as heatwaves causing greater frequencies of demand restrictions, and flooding causing disruptions to supply, may result in higher numbers and different types of customer enquiries or complaints. This may in turn impact upon SEW's performance against Ofwat's Service Incentive Mechanism and other comparative assessments. |
| Increased risk of loss of service from suppliers - e.g. electricity, chemical suppliers, etc | SEW may be affected where suppliers cannot deliver a service on which SEW relies, such as power, supply-chain requirements (e.g. chemicals) and personnel/contractors. |
| **Facilities Management** | |
| Increased need for air conditioning | Increased temperature variability may impact upon working conditions for SEW staff, both in offices and vehicles. |
| Potential risk of spread of disease in trees in SEW landholdings | Potential increase in spread of major tree diseases as a result of climate change. Potential liability for trees on SEW landholdings. |
| Potential public health impact of algal blooms in reservoirs used for recreation | Algal blooms in reservoirs may result in safety and public health problems, and potential for claims against SEW because of ill health. |
| **Finance and Investment** | |
| Vulnerability to political stances on climate change | Changes to political stances in relation to climate change may impact upon SEW if increased scrutiny of adaptation efforts arises which could potentially impact upon the Company's reputation. It may also require the Company to focus more on particular measures, e.g. metering. |
| Reduced financial rating and increased cost of capital | Climate change and the vulnerability of companies to its effects may become a measure by which companies' credit ratings are assessed and which may affect investor confidence and in turn the cost of capital. This impact is likely to be low for SEW as a regulated company. |
| Greater OPEX reflecting additional impacts of climate change | Higher operational costs as a result of the impacts listed here. |

## 3.4 Prioritising climate risks

The climate risks were entered into a matrix, where each risk was detailed with the evidence supporting it and how is currently being addressed by the Company. This matrix is provided in the Appendix B, with the information given according to the following headings:

Business Function

Impacts were addressed by Company business function, i.e. Water Resources, Asset Management, Water Quality, Energy and Carbon, Biodiversity and Conservation, Organisational Capacity, Customer Services, Facilities Management, and Finance. By categorising the climate risks in this way, it was simpler to target the appropriate staff and supporting evidence for input.

Climate Variable

The relevant climate variable for that risk, e.g. extreme rainfall events, multi-season low rainfall, daily maximum temperature, etc.

Description

A description of the nature of the risk, including what is at risk and where (the receptor).

Sensitivity / Threshold

Detail on how the receptor is sensitive to climate and whether there are any thresholds above which this sensitivity changes. In many instances, a particular threshold has not been calculated by the Company as this requires very specific quantitative assessments.

Change in Exposure

A description of how the relevant climate variable(s) may change and how the change is included in modelling or assessments.

Assessed Risk

Specific information regarding the level of risk, e.g. the outcome of modelling showing the potential reduction in Deployable Output as a result of climate change.

Overall Risk

To prioritise adaptation action towards significant impacts, with reference to the approach advocated in Defra's guidance, each climate risk was assigned a qualitative risk indicator of 'Low', 'Medium', 'Medium-High' or 'High'. This is a qualitative assessment, but was based on explicit assessment of components of vulnerability and on the evidence included in the matrix, supported by the risk scoring exercise undertaken with SEW staff.

Evidence / Source

The source(s) of evidence for the risk.

Pedigree

The pedigree of the evidence is given a rating from A to D as follows: A (quantitative SEW study), B (qualitative company study), C (industry-wide study) or D (dialogue with SEW staff). Use of a pedigree rating is consistent with the National Climate Change Risk Assessment, although a different rating system is used here.

Gaps

A description of any particular gaps in the evidence.

The 'Overall Risk' category described above was used prioritising risks to carry through for adaptation action. Priority risks can be considered as those which are considered to result in the most significant impact on SEW or its stakeholders, or/and those which require immediate practical action or investigation. As discussed above, the workshop held with SEW staff was used as an opportunity to identify the most pressing risks for SEW's operations and stakeholders from the perspectives of specialist staff across the Company.

Those impacts that were considered to pose a Medium-High or High risk to the Company were taken forward to the next stage. These risks are listed below:

- Reduction in surface water availability;
- Reduction in groundwater availability;
- Increasing demand in warmer weather;
- Increase in risk of fluvial flooding;
- Increase in risk of groundwater flooding;
- Increase in risk of surface water flooding;
- Increases in leakage/burst frequency;
- Increase in outages from bad weather affecting assets and power supply; and
- Increased land runoff.

In the following section of the report, adaptation responses that may reduce these priority impacts are presented. Additional complexities relating to these proposed adaptation responses are considered, e.g. uncertainties in evidence and barriers to successful implementation.

# 4. Developing adaptation plans

The purpose of Task 2 is to develop adaptation plans for the priority climate risks identified in Task 1 (see Section 0). A long list of potential options was developed with reference to the Water UK approach for adaptation in asset management and the UKWIR CL01 study. This was supported by evidence from within SEW, including the WRMP, Business Plan and outputs from the workshop undertaken with SEW staff.

This section provides a discussion of the factors on which potential adaptation options may be dependent, and what impact they may have on other business areas or stakeholders. It then goes on to describe the criteria used to assess each option in order to provide a refined shortlist of 'favourable' options, from which a final set of options is identified for the Company's adaptation plan.

## 4.1 Actions to adapt to climate risks

In broad terms, the adaptation actions form around two strategic themes:

- Adaptive management; and,
- Partnership working.

These are discussed in further detail below.

### 4.1.1 Adaptive management

Adaptive management describes a process of adapting whilst managing uncertainty. This is achieved by incrementally adjusting ongoing activities to account for the impact of climate change whilst monitoring impacts and adaptations to identify further need for action. For SEW this strategy will encompass:

- **Monitor and act approach:** SEW currently undertakes a lot of monitoring; however, the links to climate variables (e.g. monitoring burst frequency of pipes in relation to temperature profiles) needs to be strengthened. The results obtained from monitoring programmes and the identification of any associated trends in outcomes will allow SEW to develop and employ appropriate risk management measures. In many of its current operations, SEW uses monitoring to identify and trigger action, e.g. monitoring water levels at sources to implement appropriate drought actions. In future, there will be a separate requirement to consider long-term changes that need potentially larger (strategic) or new solutions, such as new reservoirs to provide winter storage capability in the face of increased winter and lower summer rainfall volumes. SEW will look to implement 'Low' or 'No' regret options, particularly those that require consideration of climate change impacts in current procedures (i.e. as a key objective/test within strategies, plans and design).
- **Reviewing plans:** SEW works to a number of plans, both for statutory reporting purposes and operational reasons, which include management of climate-related risks. These plans will be reviewed when they come up for renewal in light of potential climate change impacts, with SEW proposing adaptation measures as appropriate. These plans are, however, subject to regulatory approval; therefore effective regulatory direction will be required that acknowledges and allows for long-term climate change to drive investment where it is shown to be robust.
- **Communications strategy:** communications regarding adaptation, within SEW and with its stakeholders, are important and not straightforward. SEW will ensure that its communications, including publications, strategies and plans, integrate an evidenced-based assessment of climate change risks and adaptation requirements. In the majority of instances, climate change may not be a sole driver for action but may add considerable

weight of evidence for investment in particular responses or a particular strategy. For its communications strategy to be effective, particularly in relation to its customers, SEW will prepare/provide appropriate information tailored to each stakeholder group. Although the purpose is to influence and inform, it is necessary to avoid the perception of 'greenwashing'.

### 4.1.2 Partnership working

Working in partnership in particular with other water companies and water industry regulators will help address barriers to individuals and organisations:

- **Research and innovation:** by the water industry or by SEW in partnership with other key stakeholders will help to identify impacts and adaptations in a number of areas, particularly where an impact requires regulatory changes and/or actions across a number of fronts for successful adaptation.
- **Influencing regulation:** as discussed above, the previous lack of regulatory support for climate change-driven investment will need to be reformed. Regulators must provide a clear framework that supports companies' investment in adaptation where there is good evidence for business risks (and opportunities). This approach must balance the geographical variability and complexity in impacts and adaptation, whilst maintaining consistency across the industry. SEW will regularly review its proposed adaptation measures to ensure consistency with regulatory approaches and policy steers.
- **Working with local delivery partners including customers:** to help deliver adaptation across sectors.

## 4.2 Uncertainty

There are a number of uncertainties inherent in developing climate change adaptation plans. New industry R&D projects are focussing more on the nature of the risks and thresholds/tipping points within existing assets, infrastructure or processes. This will help identify where key business risks lie and provide the evidence to support regulatory understanding and prioritise appropriate and risk-based investment in adaptation.

SEW has an extensive monitoring and sampling system in place, but as discussed in Section 2.2.1.1, the Company has not as yet undertaken focussed climate change impact assessments beyond those areas required in statutory reporting methodologies.

Sector-wide projects are both ongoing and planned in some areas of climate change impact assessment. One of the streams of research areas in UKWIR, for example, is on climate change. Current and planned UKWIR projects on climate impacts and adaptation cover:

- Climate change modelling for sewerage networks;
- Climate change implications for water treatment;
- Climate change and wastewater treatment;
- Impact of climate change on source yields; and
- Impact of climate change on asset management planning.

Within the industry, one of the key mechanisms by which uncertainty is currently managed in the context of water resources is use of probabilistic modelling to derive 'target headroom'. It is expected that this approach may be rolled out to other areas of water company planning in future; however, this would likely require regulatory approval, which is currently considered a barrier for most adaptation measures unless they fit with current priorities, e.g. metering, demand management. This is discussed further in the following section.

Uncertainty has been included in the risk assessment undertaken in Task 1, and considered as part of the prioritisation of risks. Uncertainty in adaptation options is considered as part of the identification of barriers to successful implementation, but also with regard to potential regret. For example, if there is uncertainty with regard to the suitability or likely success of an adaptation option, it is more likely to be classed as medium or high potential regret. Potential regret must, however, be balanced against an assessment of the risk to SEW's business and customers of doing nothing. This emphasises the potential benefit of using a threshold-based approach where possible, not based on climate per se but one that identifies the conditions under which particular tipping points may occur and the risks they would impose on the business.

## 4.3 Barriers to adaptation

Focus on the uncertainty of climate change outcomes has resulted in significant regulatory caution and a general lack of support for any schemes with a climate change driver. Other barriers, perceived and real, also exist. The list below, whilst not exhaustive, highlights the types of barriers that may currently stand in the way of successful adaptation. Barriers specific to SEW's proposed adaptation responses can be found in Table A3.1.

- **Regulatory:** different pressures imposed by different water industry regulators result in companies needing to develop options that meet opposing objectives, e.g. Ofwat: least cost outcome; EA: best environmental outcome. Although the regulatory framework has a long-term view (25 years ahead), there is no unified approach through which adaptation to the long-term risks of climate change can be implemented, which is particularly important for the management of uncertainty in climate change impacts.
- **Financial:** some adaptation options, e.g. increased winter storage capacity, effluent re-use, desalination, etc, may have significant short/medium-term financial consequences, but position the Company to meet long-term needs. Inevitably with large investment, there will be increased scrutiny of the need; therefore where climate change is a major driver, risk and uncertainty will need to be balanced appropriately. However, where a need has been identified based on current drivers, e.g. a supply-demand deficit including moderate climate change impacts, climate change adds weight to the evidence of need.
- **Environmental constraints:** e.g. designated conservation areas, which may limit the extent of new development relating to water resources or water treatment works not just identified in adaptation plans but in all plans. Other issues include potential restrictions on transfer schemes of untreated water to prevent the spread of non-indigenous species. SEW will look for options that will provide, where feasible, a net environmental gain to ensure it achieves support.
- **Technical:** issues such as knowledge of impacts, and the ability to apply climate information to company-specific assets and circumstances.
- **Socio-political:** there may be resistance to some supply-side measures if they require large amounts of construction; similarly demand management in the form of metering and tariff setting will raise issues of affordability that will need to be addressed. This emphasises the need for a balanced assessment of drivers and risk so that customers, investors and regulators can see a clear case for action/investment that weighs up current and future need.
- **Competition:** the advent of competition may make inter-company cooperation more difficult/complicated in the case of shared resources and joint schemes.

The barriers identified will assist in formulating appropriate steps necessary for successful promotion of preferred options. For example, there may be preparatory or investigation work necessary before an option can be implemented. This will then be reflected in the implementation section of Task 3; the proposed first step for an option will reflect that there may be several

different stages to implementation, and these may involve overcoming barriers before substantial progress can be made.

## 4.4 Interdependencies

It is likely that some adaptation options may result in knock-on impacts elsewhere in catchments, on other parts of SEW's business, on stakeholders or on carbon emissions. These impacts may be positive or negative. An example of a positive impact would be where a company improving internal connectivity around its distribution network by constructing new mains and/or pumping stations, which would increase serviceability for customers and may also open up opportunities for sharing or trading water with neighbouring companies; thus multiple benefits arise, although there is an increase in energy consumption for pumping. Conversely, if a company were to accept worsening water quality and hence increase water treatment capacity to cope, this would result in higher energy usage and an increase in carbon emissions for just a single benefit.

SEW is aware of potential impacts of climate change 'upstream' of its operations, i.e. in the supply chain. It is expected that climate change may have an impact both on the availability of resources such as power and chemicals, which SEW will incorporate into its adaptation plan.

Dialogue with regulators and other stakeholders through existing channels (e.g. SEA, water resources and business planning, procurement processes etc.) will form part of SEW's adaptation plan for all options. This will be reflected in the Company's communications strategy. In this way, knock-on impacts (both of SEW's actions on others, and of others' actions on SEW) are identified, reduced and/or removed where appropriate.

## 4.5 Adaptation option appraisal

A qualitative assessment of adaptation responses that address SEW's priority risks has been undertaken. Each response was assessed in terms of the following criteria, the findings of which are summarised in the matrix presented in Appendix 3:

Barriers

Potential barriers to the successful implementation of each option are listed. These may include factors such as technical limitations, regulatory issues, acceptability, and uncertainty in achieving results. Barriers were discussed with SEW staff at a workshop event, and are noted here, along with others identified from relevant literature.

Cost-benefit ratio

Defra, the Treasury Green Book guidance and UKCIP good adaptation principles stipulate that the cost of an adaptation measure must be proportionate to the risk it addresses and therefore the benefits that are yielded. It is important therefore that the costs and benefits of each adaptation option are assessed as part of any option appraisal; however, it is acknowledged that in many cases detailed costs and benefits will not yet be known, and in fact in some cases will be difficult to quantify.

In this assessment, each option is given a cost-benefit ratio as a score of low, medium or high for each; therefore, for example, a low cost option with a medium benefit would give a ratio of 'L:M'. These scores are not based on a quantitative approach, but give an indication of the relative ratio between options. The cost element considers both the CAPEX and OPEX of the option for its lifetime, including start-up and maintenance costs.

Timescale

This is the timescale over which the option could be successfully implemented, and is given a score of 'Short-', 'Medium-', or 'Long-term'. The designations are broadly aligned with water industry cycles; options achievable in the next AMP cycle period is classed as 'Short', options for

the next 25-year strategic planning period are 'Medium' and anything beyond that is classed as 'Long'.

Sustainability principles

In the context of the wider implications of implementing an option, each option should be equitable, meaning it should avoid imposing significant disproportionate costs on individuals, groups or the natural environment. The options are assessed according to environmental, economic and social sustainability principles; with each option classified as Increasing (↑), Decreasing (↓) or Maintaining (-) each of the three principles.

Where the short-term and long-term impacts differ substantially, they have been included separately for that option.

Carbon impact

Each option is also assessed with regard to the carbon emissions associated with its implementation. This is a significant issue where SEW is also required to undertake mitigation of emissions in operations, and ideally there would not be a conflict with adaptation actions. Options are classified as either 'Low', 'Medium' or 'High'. Most options are classed as 'Low' – for example, where the options is to under further investigations; however, some have a higher classification – for example, where the options results in increases in energy usage.

Potential regret

This final column is an assessment of the potential regret associated with implementing that option, and takes into consideration the ease and cost of reversing the decision once the option is put in place, the uncertainty of its success, and the wider benefits the option may have. Each option is given a classification of 'High', 'Medium', 'Low' or 'No' – the last of these is specifically for options that are sensible courses of action regardless of adaptation planning, particularly if they are low cost and have wider benefits above and beyond climate change adaptation.

### 4.5.1 Favourable adaptation responses

Based on the outcome of this process, the adaptation options were categorised for their overall 'favourability' according to a traffic light system of Green (more favourable), Amber or Red (less favourable). All green and amber options were then carried through to develop the adaptation plan, which is described in Section 5.

Within the timescale for preparation and submission of this report to Defra, it has not been possible to assess adaptation responses in a more quantitative manner. Existing water company funding processes (formal business planning in the lead up to Periodic Reviews, as well as Ofwat's Change Protocol, discussed in Section 1.3.1) will require companies to develop their proposals for adaptation responses with a more quantitative basis. In this way, SEW will shape the proposals derived through this reporting (screening) process into more defined, targeted schemes for adapting to climate change.

# 5. Implementation and monitoring

## 5.1 Identification of next steps

Table 5.1 shows the 'Green' and 'Amber' favourable adaptation options from Section 4 and the next steps that the Company proposes to take to implement them. The table also shows where the Company or the water industry as a whole is already undertaking work towards adaptation; this is particularly relevant for monitoring activities and research. Where action is not proposed for an adaptation option, the reason or barrier for this is noted. Finally, the table identifies how each step will be monitored for evaluation.

## 5.2 Proposals for monitoring and evaluation

A monitoring and review plan is included within Table 5.1 for each of the Company's adaptation options. The aim of this section is to outline at a more strategic level how SEW will assess its progress over time against adaptation objectives, which will consequently allow it to determine whether adaptation measures have achieved desired outcomes and whether there have been any unintended consequences.

### 5.2.1 Timescales

In this first climate change adaptation report, many of the adaptation actions proposed by SEW are investigative or monitoring activities. The majority of these are undertaken and reviewed routinely by the Company as part of its operational strategy or reviewed to form the basis of decision-making as part of the Company's Business Planning or Water Resources Management Planning processes in the run up to Periodic Reviews.

The nature of these proposed activities reflects the Company's awareness of the importance of the next 2-3 years for ensuring that information is available or reviews are carried out to inform investment proposals at the next Periodic Review, PR14. To obtain funding for climate change investment in the meantime, before PR14, the Company would need to utilise Ofwat's notified item process. In light of the time required to build up a supporting evidence base where possible, PR14 will be the next critical milestone for enabling the Company to move forward with climate change adaptation investment proposals. At present, as illustrated in this report, the Company's focus is on ensuring that it is as prepared as possible at PR14 to make informed investment decisions.

### 5.2.2 Flexibility

The Company's climate change adaptation strategy leading up to PR14 is designed to allow informed investment decisions to be made, whilst ensuring that flexibility remains central to its decision making around potential climate change implications. This strategy is underpinned by use of an adaptive management approach, whereby ongoing activities are incrementally adjusted to account for the impact of climate change, whilst monitoring impacts and adaptations to identify further need for action.

As part of its adaptive management approach, SEW has incorporated into its appraisal of adaptation options a qualitative estimate of potential regret. This considers the ease and cost of reversing the adaptation measure once it has been put in place, the uncertainty of its success, and any wider benefits the option may have. This measure of flexibility was taken into account in the selection of options for the Company's adaptation plan, shown in Table 5.1.

### 5.2.3 Residual risk over time

Increasing awareness of climate change and moving towards increased data availability to inform climate change impact assessments will ensure that over time, climate change is increasingly accounted for in the Company's investment decisions. It is expected that over time, as a result of these actions, the headroom allowance in its WRMP for uncertainty over the impacts of climate change will reduce.

In its adaptation plan, SEW emphasises the importance of partnerships with other water companies, water industry regulators and local delivery partners including customers in informing climate change impact assessments, contributing towards flexible approaches to adaptation, and overcoming barriers to adaptation.

Over time the results of SEW and industry-wide research into climate change impacts will provide detail that is currently lacking on the sensitivity of certain receptors to climate variables; this in turn will assist in identifying thresholds above which receptor sensitivity changes. To date, in many instances, particular thresholds have not been calculated by the Company as they require very specific quantitative assessments. In addition to industry-wide research where applicable, the Company's adaptation plan proposes that quantitative assessments be carried out, where supporting data is available, as part of preparatory work at PR14.

Table 5.1 – Proposed Adaptation Actions and Evaluation

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| **Risk - Reduction in surface water availability** | | | | |
| Develop conjunctive use schemes | Four conjunctive use schemes were considered as part of the constrained options list in SEW's Revised WRMP, although none made it through to the feasible options list. | Yes | Further investigation and consultation will be undertaken in preparing the next WRMP. If options feasible, regulatory support required to allow implementation. | Review during WRMP drafting. |
| Increase reservoir capacity | In its Revised WRMP, SEW has proposed two winter storage reservoir options: Broadoak and Clay Hill, along with raising Bewl reservoir, all in the period 2021-35. | Yes | Further investigation and consultation will be undertaken in preparing the next WRMP. If feasible, planning, consents and regulatory support required to allow implementation. | Review during WRMP drafting. |
| Reduce water lost through leakage | In its Revised WRMP, SEW has proposed to reduce leakage in four of its WRZs from 2010-20, through pressure management and reducing customer supply pipe losses. | Yes | Already underway, although ultimately limited by (current level of) SELL. | Regular monitoring already undertaken and reported annually via June Return. |
| New surface water abstraction | | Yes | This option will be investigated. | Review during WRMP drafting. |
| Inter-company transfer | In its Revised WRMP, SEW has proposed the continuation of imports from other companies (Southern Water and Veolia Water Central in particular). | Yes | Liaising with bulk suppliers regarding future options with respect to climate change. | Review in partnership with other companies during preparation of WRMP. |
| Intra-company transfer | In its Revised WRMP, SEW has proposed improvements to its infrastructure to enable water to be transferred between WRZs. | Yes | Further opportunities will continue to be reviewed as options for the next WRMP | Review during WRMP drafting. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| Maximising reservoir yield | | Yes | Capital Maintenance Plan surveys and future option work | Review at next renewal of Capital Maintenance Plan |
| Effluent re-use | In its Revised WRMP, SEW has proposed the Aylesford Effluent Reuse scheme (2021-35) | Yes | Further investigation and consultation will be undertaken in preparing the next WRMP. If feasible, regulatory support required to allow implementation. | Review during WRMP drafting. |
| **Risk - Reduction in groundwater availability** | | | | |
| Develop conjunctive use schemes | Four conjunctive use schemes were considered as part of the constrained options list in SEW's Revised WRMP, although none made it through to the feasible options list. | Yes | Further investigation and consultation will be undertaken in preparing the next WRMP. If feasible, regulatory support required to allow implementation. | Review during WRMP drafting. |
| Artificial recharge | | Yes | Investigations and working with partners. Would require regulatory support and discharge consent. | Review during WRMP drafting. |
| Aquifer storage and recovery (ASR) | Three ASR schemes made it through to the feasible options list in SEW's Revised WRMP. None were selected as part of the Company's proposed final planning solution. | Yes | Investigate as part of optioneering process. If feasible, regulatory support required to allow implementation. | Review during WRMP drafting. |
| Abstraction licence trading | | Yes | Working with Environment Agency and local business; will feed into next WRMP. | Review during WRMP drafting. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| **Risk - Increasing demand in warmer weather** | | | | |
| Tariff change to encourage saving water | SEW has trialled a seasonal tariff in Ashford, Kent as part of the Savings on Tap project. SEW's proposal in its Revised WRMP to implement a Universal Metering programme to cover 90% of customers by 2020 will form an essential pre-requisite to further work on tariff changes. | Yes | Implementing also through engagement with partners and through behavioural change. Barriers will include ability to motivate behavioural change, demand elasticity to cost and customer acceptance of charging regime. | Review of quantitative and qualitative outputs. |
| Monitoring customer views on frequency of demand restrictions | Included as a question to customers in preparing Business Plans. | Not in the short term | Will continue as a question (e.g. for PR14) but an existing Level of Service and regulatory approval in place until 2015. | Review at PR14. |
| Expand discretionary use restrictions | Under the new Flood and Water Management Act 2010, SEW has new powers to restrict the discretionary use of water. The next revision of its Drought Plan will reveal how the Company intends to apply these new powers to restrict use of water during drought events. | Yes | Investigate and include in revised Drought Plan and next Strategic Direction Statement | Will monitor at next dry year. |
| More input to new housing development planning | In its Revised WRMP, SEW has assumed demand savings from adoption of Code for Sustainable Homes targets in new homes, as well as a reasonable level of application by developers and planners. | Yes | Engagement through Local Development Frameworks and Water Cycle Strategies, WRMP consultation, and wider partnerships with the Environment Agency and others. Potential barriers include effectiveness and reliance on engagement particularly of local authorities. Measuring benefits, and the sustainability of those benefits to different climate scenarios. | Review during WRMP drafting. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| Reduce demand through household water efficiency measures and customer marketing campaign | In its Revised WRMP, SEW has proposed a water efficiency programme in all eight of its WRZs over the whole planning period to 2035.<br><br>Demand reductions as a result of metering were assessed from SEW's own Meter Pilot Study in Canterbury and Faversham. A best estimate reduction of 10% of household demand was assumed in the WRMP, with a lower bound of 6% and an upper bound of 11%. | Yes | Implement, monitor and make adjustments to demand forecast as appropriate. Barriers include requirement for legislative change. | Ongoing monitoring. |
| Relaxation of barriers to demand options being funded through price review | | Yes | Investigate with industry and regulators. | Review at PR14. |
| Implement rainwater harvesting and grey-water reuse for domestic/commercial customers | | Yes | Investigate opportunities to trial. Will need to assess under normal and wider conditions, especially drought i.e. need to understand reliability of systems under prolonged dry conditions etc. | Review during WRMP drafting. |
| Increase in metering | The Company's meter penetration was 7% in 1994-95, 35% by 2007, and it aimed to reach 40% by 2010. In its Revised WRMP, SEW has proposed a Universal Metering programme to cover 90% of customers by 2020. | Yes | Already underway. Effective metering strategies will require development of new tariffs that will influence demand | Review at PR14. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| Monitor demand in relation to weather variables | SEW monitors measured demand through its billing database for June Return reporting purposes. | Yes | Baseline completed, but need to examine climate change scenarios, in relation to industry and regulatory guidance. | Review during WRMP drafting. |
| **Risk - Increase in risk of fluvial flooding** | | | | |
| Review any Flood Risk Assessments that cover areas where SEW assets are sited | SEW has carried out Flood Risk Assessments of all its 1,091 assets using the Ofwat 2008 methodology: Asset Resilience to Flood Hazards - Development of an analytical framework, PR09/12. This incorporates an allowance for increases in flooding due to climate change, based on EA flood mapping. | Yes | Monitoring effectiveness of chosen solutions and reviewing the assumptions in PR09/14 to ensure they remain valid. | Review at PR14. |
| Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments | SEW has carried out Flood Risk Assessments of all its 1,091 assets using the Ofwat 2008 methodology: Asset Resilience to Flood Hazards - Development of an analytical framework, PR09/12. This incorporates an allowance for increases in flooding due to climate change, based on EA flood mapping. | Yes | Continued development of climate change assessment in WRMP and BP processes. Monitoring effectiveness of chosen solutions and reviewing the assumptions in PR09/12 to ensure they remain valid. | Review at PR14. |
| Review arrangements for customer service, information and support in event of outages | | Yes | Communications team to investigate. Also industry work regarding levels of service and flooding (serviceability). | Review in relation to any future incidents. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| Implement protection or flood-proofing of assets at high risk of fluvial flooding | | Yes | Some implemented, but limited by funding. Investigations will examine longer-term projections. | Review at PR14. |
| Incorporate climate change impacted flood events into topographic mapping/asset risk tool | | Yes | Incorporate assessments into Asset management Planning and future BP submissions | Monitor how used in decision-making |
| Amend assets' insurance policies to reflect climate change-impacted flood risk | | Yes | To be reviewed. | To be reviewed by 2012. |
| **Risk - Increase in risk of groundwater flooding** | | | | |
| Review and upgrade where necessary pump duty and pump type at borehole sites | Examining current conditions and drought conditions | Yes | Assess future conditions | Review at PR14. |
| Implement changed operation and maintenance regime to deal with higher groundwater levels | | Yes | Investigation planned | Review at PR14. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| Ensure that future below ground installations (e.g. meters) are waterproof | Types of meters are being assessed; resilience to wet conditions is part of this. A lot of meters are being replaced and pit conditions are being recorded. | Yes | Investigate potential future changes | Review at PR14. |
| Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments | Not as advanced as for fluvial flooding. | Yes | Investigations planned. Requires regulatory support | Review at PR14. |
| Raise headworks | Being undertaken in relation to existing Capital Maintenance Plan and SEMD measures, for extreme recent events. | Yes | Investigate whether others vulnerable. | Review at PR14. |
| **Risk - Increase in risk of surface water flooding** | | | | |
| Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments | SEW has carried out Flood Risk Assessments of all its 1,091 assets using the Ofwat 2008 methodology: Asset Resilience to Flood Hazards - Development of an analytical framework, PR09/12. This incorporates a review of available SWMPs as well as an allowance for increases in flooding due to climate change, based on EA flood mapping. | Yes | Further investigations | Review at PR14. |
| Review any Surface Water Management Plans that cover areas where SEW assets are sited | As above | Yes | Further investigations | Review at PR14. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| Monitoring customer views on frequency of demand restrictions | | Yes | Communications team to investigate. Also industry work regarding levels of service and flooding (serviceability). | Review in relation to any future incidents. |
| Implement protection or flood-proofing of assets at high risk of surface water flooding | | Yes | Some implemented, but limited by funding. Investigations will examine longer-term projections. | Review at PR14. |
| Incorporate climate change impacted flood events into topographic mapping/asset risk tool | | Yes | Incorporate assessments into Asset management Planning and future BP submissions | Monitor how used in decision-making |
| Amend assets' insurance policies to reflect climate change-impacted flood risk | | | To be reviewed | To be reviewed by 2012. |
| **Risk - Increases in Leakage / Burst Frequency** | | | | |
| Incorporate impacts of soil wetting and drying due to climate change scenarios into SEW's existing capital maintenance planning model | SEW has incorporated three climate change perturbed variables (max. and min. temperature, frost days and sunshine hours) into its asset deterioration model for capital maintenance planning purposes. | Yes | Use model to understand potential climate change impacts. | Review at PR14 |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| Use heave-resistant pipeline materials and connected assets for system extensions/renewals | SEW constantly reviews available pipe materials selecting the most appropriate for the local ground conditions | Yes | Continue to review pipe materials available | Ongoing |
| **Risk - Increase in outages from bad weather affecting assets and power supply** | | | | |
| Review existing outage response procedures more frequently | | Yes | Investigate how often procedures should be reviewed and implement | Review at PR14. |
| Investigate alternative outage response procedures | | Yes | Investigate as described | Review at PR14. |
| Continue to monitor outage events using standardised template across sites | Outage logs maintained and used for WRMP and asset management including deterioration modelling | Yes | As described, especially for severe weather | Review at PR14. |
| Review bad weather site operation procedures | Included in emergency measures and plans | Yes | Investigate further requirements with respect to potential changes in weather | Review at PR14. |
| Use of weather-related outage as a criterion for capital scheme selection | Indirectly included e.g. asset quality | Yes | Investigate further. Also to consider related decision-making methods as company and industry. | Review at PR14. |

| Adaptation option | Current action | Further action proposed? | Proposed action or barrier to further action | Proposed monitoring and review |
|---|---|---|---|---|
| **Risk - Increased land runoff** | | | | |
| Consider as part of catchment management plans (such as WFD programme of measures), with climate change | Focused on existing conditions or risks through Water Safety Plans, MTBE projects (in partnership with owners) and engagement with River Basin Plans. | Yes | To be reviewed | Review at PR14 |
| Monitor and review; research into potential future changes | | Yes | Will investigate. Barriers include level of support from stakeholders and partners and regulatory funding. Will engage with other companies who have funded land management projects. | Review during WRMP drafting. |
| Liaison with stakeholders (e.g. NFU) | | Yes | To be reviewed | Review at PR14 |
| Education and awareness on management practices for land owners | | Yes | To be reviewed | Review at PR14 |

# 6. Conclusions

## 6.1 Conclusions

This report has been written in response to Defra's direction to report under the Climate Change Act 2008. As a reporting authority, this report details SEW's progress towards adaptation to climate change. In producing the report, the Company has used Defra's statutory guidance in completing the following three main tasks:

- **Assessing risks, identifying threats and opportunities** – Identification and prioritisation of climate change impacts by business function. Climate change science, company literature, wider research studies and Company expertise have been used to develop a comprehensive list of potential climate change impacts on the Company's activities and customers. A list of nine priority risks were identified (and carried through to the next task):
    - Reduction in surface water availability;
    - Reduction in groundwater availability;
    - Increasing demand in warmer weather;
    - Increase in risk of fluvial flooding;
    - Increase in risk of groundwater flooding;
    - Increase in risk of surface water flooding;
    - Increases in leakage/burst frequency;
    - Increase in outages from bad weather affecting assets and power supply; and
    - Increased land runoff.
- **Developing adaptation plans** – Adaptation options have been identified for these priority risks. A long list of potential options was developed from industry research; each was then assessed for favourability according to a series of criteria, including cost-benefit, carbon impact and potential regret. Based on the scoring for these criteria, each option was scored for overall favourability as either 'Green', 'Amber' or 'Red'. Green and Amber options were subsequently carried though to the final part of the study.
- **Implementation and monitoring** – In this final task, an implementation and monitoring plan was developed for the Company. For each of the options from the previous task, a next step was proposed, in view of any current relevant actions being carried out by the Company. For each action proposed, a method of monitoring is also included for the ongoing evaluation of the plan.

In completing these tasks, and the reporting as a whole, SEW believes it has met the requirements as a reporting authority and has developed a robust plan for implementing adaptation across its business.

## 6.2 Embedding Adaptation

Completion of this report has allowed SEW to consider the issue of climate change adaptation as a whole company, rather than by individual sector in response to each regulatory requirement. The process followed has identified how adaptation is currently being addressed across the Company and has helped identify where this work is currently focussed.

In developing an implementation and monitoring plan, the Company acknowledges that there is substantial benefit from embedding adaptation into standard practices – essentially making adaptation part of 'business as usual'. The assessment of climate change risks will become increasingly necessary for both short- and long-term planning for the Company, for which identification of suitable adaptation options is then possible. The information provided in this report shall form a source from which future adaptation assessments can draw – helping to ensure that the Company has a consistent basis for adaptation.

# 7. References and Evidence List

The following list is both the references used in this document and a full list of the evidence used to develop the impacts matrix. The former are indicated by an asterisk.

2030 Water Resources Group. 2009. *Charting Our Water Future - Economic frameworks to inform decision-making*, McKinsey Quarterly, New York, 185pp.

Adaptation Sub-Committee. 2010. *How well prepared is the UK for climate change?,* First report of the Adaptation Sub-Committee, Committee on Climate Change, London, 72pp.

Alexander Ballard Ltd. 2010. *South East Water Climate Change Adaptation Self Assessment Part 1: PACT Report Summary*, Defra, London, 9pp.

Alexander Ballard Ltd. 2010. *South East Water Climate Change Adaptation Self Assessment Part 2: PACT Pathways Analysis*, Defra, London, 23pp.

Aquaterra. 2008. *WRMP Appendix 4.1: South East Water Deployable Outputs, testing the resilience of surface water and groundwater sources to severe drought*, Aquaterra, Lewes, 80pp.

*Arkell, B., Darch, G., Jeal, G., McSweeney, R., Sutherland, J., Thornton, A. and Williams, N. 2008. *Climate Change – A Programme of Research for the UK Water Industry. Volume 2 – Technical Report*. UKWIR, London.

Atkins. 2007. *WRMP Appendix 4.5: Deployable Output Re-Assessment, for Mid Kent Water*, Atkins Limited, Epsom, 28pp.

Atkins. 2008. *WRMP Appendix 4.2: Groundwater deployable output return period analysis*, Atkins Limited, Epsom, 10pp.

Black & Veatch. 2009. *Resilience Study: Single Source of Supply – Resource Zones 1, 2 & 3,* Black & Veatch Limited, Redhill, 142pp.

Black & Veatch. 2009. *Resilience Study: Single Source of Supply – RZ2 Loss of Barcombe WTW,* Black & Veatch Limited, Redhill, 26pp.

Black & Veatch. 2009. *Resilience Study: Single Source of Supply – Resource Zones 4 & 5,* Black & Veatch Limited, Redhill, 120pp.

CFonstream. 2009. *Proof of evidence on Demand Forecasting and Supply-Demand Management*, CFonstream, Reading, 117pp.

CFonstream. 2009. *Rebuttal Proof of evidence on Demand Forecasting, Demand Management and Per Capita Consumption*, CFonstream, Reading, 28pp.

CPWC. Undated. *Climate change adaptation in the water sector – Financial issues*, Co-operative Programme on Water and Climate, The Hague, 16pp.

Defra. 2009. *Adapting to Climate Change: helping key sectors to adapt to climate change, Statutory Guidance to Reporting Authorities*, Defra, London, 38pp.

Dolphin Ecological Surveys. 2009. *Arlington Reservoir SSSI and LNR: Five year management plan 2007-2011*, Dolphin Ecological Surveys, Uckfield, 15pp.

Dolphin Ecological Surveys. 2009. *Wych Cross Reservoir: Five year management plan 2007-2011*, Dolphin Ecological Surveys, Uckfield, 7pp.

Dolphin Ecological Surveys. 2009. *Rathfinny Boreholes: Five year management plan 2007-2011*, Dolphin Ecological Surveys, Uckfield, 6pp.

Dolphin Ecological Surveys. 2009. *Hazards Green WTW: Five year management plan 2007-2011*, Dolphin Ecological Surveys, Uckfield, 15pp.

Dolphin Ecological Surveys. 2009. *Folkington Reservoir: Five year management plan 2006-2010*, Dolphin Ecological Surveys, Uckfield, 10pp.

Dynamco. 1993. *Waterworks road source: appraisal of source and recommendations*, Dynamco Limited, Haywards Heath, 34pp.

Economic Commission for Europe. 2009. *Guidance on Water and Adaptation to Climate Change*, United Nations, Geneva, 144pp.

Entec. 2010. *UK Climate Change Risk Assessment: Biodiversity Sector Workshop Record*, Defra, London, 53pp.

Environment Agency. 2009. *Adaptation Reporting Power: Supplementary Guidance for Reporting Authorities*, Environment Agency, Bristol.

Environment Agency. 2009. *River Basin Management Plan: South East River Basin District*, Environment Agency, Bristol, 62pp.

Environment Agency. 2009. *River Basin Management Plan: South East River Basin District – Annex A: Current state of waters*, Environment Agency, Bristol, 31pp.

Environment Agency. 2009. *River Basin Management Plan: South East River Basin District – Annex G: Pressures and risks*, Environment Agency, Bristol, 51pp.

Environment Agency. 2009. *River Basin Management Plan: Thames River Basin District*, Environment Agency, Bristol, 89pp.

Environment Agency. 2009. *River Basin Management Plan: Thames River Basin District – Annex A: Current state of waters*, Environment Agency, Bristol, 27pp.

Environment Agency. 2009. *River Basin Management Plan: Thames River Basin District – Annex G: Pressures and risks*, Environment Agency, Bristol, 31pp.

Gentry, B.S. 2007. *Investing in a Lower-Carbon, More Climate-Proof Future: Options, Tools, Mechanisms Background Paper on Investment and Finance to Address Climate Change*, Centre for Business and the Environment, Yale University, 41pp.

Halcrow. 2008. *South East Water - Eastern Area Kent (Former Mid Kent) SEMD Study – Single Source Outage,* Halcrow Group Limited, Snodland, 72pp.

HR Wallingford. 2007. *WRMP Appendix 5.3: Report on climate change impacts on household demand in the former South East Water Company*, HR Wallingford Limited, Wallingford, 66pp.

HR Wallingford. 2008. *Time series data for South East Water: Development of climate change scenario time series for South East Water's Capital Maintenance Planning model*, HR Wallingford Limited, Wallingford, 26pp.

HR Wallingford. 2010. *UK Climate Change Risk Assessment: Water Sector Workshop Record*, Defra, London, 76pp.

HR Wallingford. 2010. *UK Climate Change Risk Assessment: Flood and Coastal Erosion Sector Workshop Record*, Defra, London, 47pp.

IIGCC. 2010. *Investment attitude towards climate change becomes key to asset manager selection process*, Institutional Investors Group on Climate Change, London, 3pp.

IIGCC. Undated. *Investment statement on climate change*, Institutional Investors Group on Climate Change, London, 3pp.

Jacobs. 2008. *WRMP Appendix 4.3: Review of Ouse and Cuckmere Resource System Deployable Output and Drought Management*, Jacobs, Reading, 218pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Report Overview (Stages 1 – 3),* Jacobs, Reading, 25pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 1 – Risk screening: Eastern Region (East) (formerly Mid Kent Water),* Jacobs, Reading, 37pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 1 – Risk screening: Eastern Region (West) (formerly Southern Region),* Jacobs, Reading, 31pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 1 – Risk screening: Western Region (formerly Northern Region),* Jacobs, Reading, 28pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 2 – Risk analysis: Eastern Region (East) (formerly Mid Kent Water),* Jacobs, Reading, 33pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 2 – Risk analysis: Eastern Region (West) (formerly Southern Region),* Jacobs, Reading, 31pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 2 – Risk analysis: Western Region (formerly Northern Region),* Jacobs, Reading, 25pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 3 – Risk management: Eastern Region (East) (formerly Mid Kent Water),* Jacobs, Reading, 43pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 3 – Risk management: Eastern Region (West) (formerly Southern Region),* Jacobs, Reading, 77pp.

Jacobs. 2009. *South East Water Flood Risk Assessments Stage 3 – Risk management: Western Region (formerly Northern Region),* Jacobs, Reading, 58pp.

Mid Kent Water. 2007. *Statutory Drought Plan*, Mid Kent Water, Snodland, 57pp.

*Ofwat. 2008. *Water supply and demand policy*, Ofwat, Birmingham, 15pp.

Ofwat. 2009. *Climate change: good practice from the 2009 price review*, Ofwat, Birmingham, 36pp.

Ofwat. 2009. *Change protocol for 2010-15: Principles and outline procedures for companies to seek financial adjustments relating to changes to outcomes in the 2010-15 period,* Ofwat, Birmingham, 24pp.

Scott Wilson. 2008. *WRMP Appendix 4.4: Reassessment of Water Company Yields, RZ 1 to RZ5*, Scott Wilson, Guildford.

South East Water. 2007. *Statutory Drought Plan*, South East Water, Haywards Heath, 112pp.

South East Water. 2007. *Strategic Direction Statement*, South East Water, Snodland, 32pp.

South East Water. 2008. *WRMP Appendix 6.1: Target Headroom Report*, South East Water, Snodland, 31pp.

South East Water. 2009. *WRMP Appendix 5.4: Sustainable Level of Leakage Report*, South East Water, Snodland, 34pp.

South East Water. 2009. *WRMP Statement of Response*, South East Water, Snodland, 27pp.

South East Water. 2009. *WRMP Appendices to Statement of Response*, South East Water, Snodland, 69pp.

South East Water. 2009. *Energy and Carbon Emission Strategy*, South East Water, Snodland, 10pp.

South East Water. 2009. *Energy and Carbon Emission Policy*, South East Water, Snodland, 3pp.

*South East Water. 2010. *Water Resources Management Plan 2010 – 2035*, South East Water, Snodland, 348pp.

South East Water. 2010. *Energy Efficiency & the capital programme*, South East Water, Snodland, 2pp.

South East Water. 2010. *Minimise Project: Power factor correction*, South East Water, Snodland, 6pp.

South East Water. 2010. *STOR - Short term operating reserve*, South East Water, Snodland, 6pp.

South East Water. 2010. *Production Planning and Water Quality Meeting Minutes – RZs 1-3*, South East Water, Snodland, 7pp.

South East Water. 2010. *Production Planning and Water Quality Meeting Minutes – RZs 4-5*, South East Water, Snodland, 10pp.

South East Water. 2010. *Production Planning and Water Quality Meeting Minutes – RZs 6-8*, South East Water, Snodland, 8pp.

South East Water. 2010. *Special Report to Ofwat: Impact of the recent cold weather on burst mains, Distribution Input and leakage*, South East Water, Snodland, 5pp.

South East Water. 2010. *Press Release No. 25: Kent joins together to use water wisely*, South East Water, Snodland, 3pp.

South East Water. 2010. *Press Release No. 38: Water lot of top tips to save H20*, South East Water, Snodland, 3pp.

South East Water. 2010. *Press Release No. 49: South-East water supplies remain healthy despite hot weather*, South East Water, Snodland, 3pp.

South East Water. 2010. *Press Release No. 55: Bexhill woman wins new butt*, South East Water, Snodland, 3pp.

South East Water. 2010. *Press Release No. 74: South East Water hits the road to water efficiency*, South East Water, Snodland, 3pp.

South East Water. 2010. *The Water Supply (Water Quality) Regulations 2000 (Amendment) Regulations 2007 Risk Assessment Report: Bewl Bridge WTW*, South East Water, Snodland, 27pp.

South East Water. 2010. *The Water Supply (Water Quality) Regulations 2000 (Amendment) Regulations 2007 Risk Assessment Report: Barcombe Mill No. 1 WTW*, South East Water, Snodland, 24pp.

South East Water, 2010. *Environmental & Social Achievements 2009/10*, South East Water, Snodland, 28pp.

*Water UK. 2007. *A Climate Change Adaptation Approach for Asset Management Planning*, Water UK, London, 13pp.

# Appendix A – Defra Direction Letter

Jo Stimpson
South East Water Ltd
Rockfort Road
Snodland
Kent
ME6 5AH

Adapting to Climate Change
Area 3A
Nobel House
St Smith's Square
London
SW1P 3AL

February 2010

Dear Ms. Stimpson,

***Direction to report on adaptation under the Climate Change Act 2008***

We sent you a draft Direction for comment on the 15 December 2009. As we received no response from your organisation, we assume you had no concerns and so are now formally issuing the Direction. In this letter we explain the Direction, the reporting process, and answer questions that have arisen from other reporting authorities' responses.

Please find the Direction attached; this is a legal instrument, which places a requirement on you to report, outlining the issues covered in the Direction, and to deliver a report **by 31 January 2011**.

## 1. Amendment to the explanatory note to the Direction

Please note that we have made a slight amendment to the explanatory note of the Direction, and removed the points (b) and (c) from the following paragraph:

"In preparing the report, the reporting authority is required by section 63(3) of the Climate Change Act 2008 to have regard to:

a) the guidance issued by the Secretary of State under section 61 of the Climate Change Act 2008;

b) the most recent report under section 56 (report on impact of climate change) of the Act (if there is a report);
c) the most recent programme under section 58 (programme for adaptation to climate change) of the Act (if there is a one)."

We removed (b) and (c) after some reporting authorities had expressed concerns that they would have to back track and re-do parts of the report if the report on the impact of climate change and programme for adaptation to climate change came into force during the reporting process. In reality, (b) refers to the UK's first Climate Change Risk Assessment and (c) refers to the National Adaptation Programme neither of which will be published until 2012, after this round of reporting has ended (November 2011). To avoid any confusion, and to take reporting authorities' concerns on board, we have removed points (b) and (c).

## 2. Devolution and Coverage of the Direction

The Secretary of State has the power to issue Guidance and Directions to reporting authorities in Wales, Scotland and Northern Ireland, in relation to their non-devolved functions. Where appropriate we have consulted or sought consent from the government of devolved administrations as required by section 64 of the Climate Change Act 2008 and this has been given. The Direction does not apply in respect of any devolved functions of your organisation. The Direction does not apply in respect of any activities of the reporting authority which are: (i) outside of the United Kingdom; and (ii) which do not relate to any of its functions within the UK that are of a public nature or are part of its role as a statutory undertaker.

## 3. Deadlines

While some water companies stated that they would be able to meet our proposed deadline of 30 November 2010, other organisations felt that they would need longer to produce the reports. Therefore to take on board these concerns, we have decided to move the deadlines for all water companies' reports to **31 January 2011**.

## 4. Submitting the report

The deadline specified in your Direction is the deadline for submitting your report to the Secretary of State. From this date, there will be a period of 3 months after which the Secretary of State will comment on the fitness for purpose of the report. If we have judged that you have not had sufficient regard for the Statutory Guidance or fulfilled the requirements of the Direction, then you may be asked to re-do some parts of the report. You will then have 3 months to take on board comments and submit a final report to the Secretary of State. In reality therefore, if your deadline is 31 January 2011, your report may not be made publically available until August 2011.

## 5. Security and Confidentiality

We would like to reiterate that we understand that some information in your report may be sensitive for commercial or security reasons. However, the Government is committed to putting as much information as possible into the public domain, and is legally obliged to publish the full report except for information which can be withheld in accordance with the exceptions in the Freedom of Information Act 2000 (and related regulations) including the Environmental Information Regulations 2004, or for which disclosure is prohibited by another piece of legislation. **We would therefore ask you to mark any information that you think should not be published, and submit a second, redacted version alongside the complete report.** The Secretary of State will confirm that your redacted report complies with these regulations within 3 months of being submitted. If not, you may be required to re-submit your report.

## 6. Evaluation of the reports

An external risk expert institute, the Cranfield University Risk Centre, will analyse the quality of the risk assessment in each report and also produce sector summaries of the risks. Policy judgements on the basis of the reports remain the responsibility of individual government departments. The adaptation measures in the reports will be looked at by the Adapting to Climate Change Programme and officials in each relevant government department, so reports from the water sector will be examined by policy leads in Defra. They will also take responsibility for analysing and considering any actions arising from the reports for their sectors.

The combination of Cranfield's experience and departments' views will constitute the Secretary of State's response to the fitness of your report. The Adapting to Climate Change Programme alongside relevant government departments will then develop a cross sectoral summary of all the reports.

## 7. Statutory Guidance

Reporting authorities are required by section 63(3) of the Climate Change Act 2008 to have regard to Statutory Guidance when producing their reports. The Statutory Guidance was published on the 26 November 2009, and can be downloaded from our website at the following link: http://www.defra.gov.uk/environment/climate/documents/statutory-guidance.pdf. For more information on how to use the Statutory Guidance, please see our 'FAQs' which have been published on Defra's website[1]. The Statutory Guidance we have published will help you to understand what we require in a report and provide you with information on approaches to risk assessment and developing action.

[1] http://www.defra.gov.uk/environment/climate/legislation/reporting.htm

## 8. Environment Agency's Supplementary Guidance

While all reporting authorities welcomed the Environment Agency's Supplementary Guidance as an additional source of information, many requested more clarity on its level of detail and publication date. I can therefore confirm that the 'supplementary guidance' will be published on the Environment Agency's website in March 2010, which should give reporting authorities ample time to utilise it when producing their reports. It is intended to complement the Government's Statutory Guidance, but it should be noted that, **unlike the Statutory Guidance, reporting authorities are not obliged to have regard to it.**

The Environment Agency has significant expertise in planning for climate change and its guidance will make it easier to find out what the Environment Agency can and cannot provide. It signposts data, advice and tools for assessing climate risks in core Environment Agency areas, such as flood risk, coastal erosion and water resources. It also explains where the Environment Agency may be able to offer further support.

## 9. The role of Ofwat

Ofwat has also been identified as a priority reporting authority and will be asked to report on how it considers climate change will affect its ability to fulfil its functions, and what action it proposes to take on this.

The Statutory Guidance makes it clear that we expect regulatory reporting authorities to outline how their framework could provide incentives for effective adaptation. This might be through addressing market failures, most commonly by amending existing, or creating new, instruments to account for climate risk and adaptation.

Regulators will be reporting **after** those that they regulate, so that they can take into account their sector's risks and plans for adapting in their reports. We propose to share your report with Ofwat before it is made publically available for this purpose. Ofwat will not have a formal role in assessing the quality of the water sector's reports in this round but we feel it should be aware of the key messages before producing its own report. Ofwat will then want to work with Defra to consider the wider actions that may need to be taken as a result of the information gathered from the sector. Ofwat's report will also provide vital information on action which may be needed by Government to break down regulatory barriers to adaptation.

## 10. Report on adapting infrastructure in the energy, water and transport sectors to the long term impacts of climate change.

A two-year (to March 2011) cross-departmental Infrastructure and Adaptation project has been set-up to identify and examine strategic solutions to improve the long-term resilience of new and existing infrastructure in the energy, telecommunications, transport and water sectors to future climate change impacts. The project's first output, a study on the technical and operational risks from climate change on infrastructure in the energy,

transport and water sectors is currently being finalised and will be made publicly available. This will be sent to you on its completion, expected to be in March. It will also be made available via a new 'infrastructure section' on the Defra Adaptation website.

## 11. Data Gaps

In the letters and draft Directions we sent to you in December, we asked if you felt there were any gaps in the data available to you which compromised your ability to produce comprehensive reports. Some organisations identified gaps in the data around wind, snow and ice, lightning activity, flood depth (for causes other than fluvial and tidal).

Thank you for this information which is extremely useful in our continued prioritisation of our evidence strategy. We have taken these comments on board, and in particular with reference to work that we are requesting from the Met Office to enhance the current UK Climate Projections through investigating ways in which projections of wind and snow might be provided. The Met Office is also planning the publication of a technical note on lightning. The work on these issues will be carried out throughout 2010 and we will keep reporting authorities updated on its progress.

## 12. The UK's first Climate Change Risk Assessment

We would like to take this opportunity to inform you that under the Climate Change Act 2008, Defra is required to conduct a Climate Change Risk Assessment (CCRA) for the UK to lay before Parliament by 26 January 2012. I attach a summary of the risk assessment method (which is currently being piloted and so may be refined). This does not affect your requirement to report under the Adaptation Reporting Power or the Statutory Guidance to reporting authorities.

For your information the HR Wallingford-led consortium who are helping Defra undertake the CCRA are carrying out the pilot study in the water sector to test the risk assessment methodology. This involves a series of steps to understand the potential consequences of climate change. The scale of assessment is regional, so while data may be collected at a finer scale, such as water resources zones, results will ultimately be presented for Devolved Administrations and English Regions.

The pilot analysis will be based primarily on existing evidence including published water company plans, Environment Agency studies and the research literature. However the pilot would be greatly improved by collecting a small amount of additional information that underpins the current draft Water Resources Management Plans. This should be existing information and you will not be required to undertake any further analysis for the pilot. South East Water Ltd may be approached by HR Wallingford during the next two months and we would appreciate your help at this important stage.

## 13. Support

We have recently published a 'Frequently Asked Questions and Answers' pack on our website[2]. There is no statutory requirement for any reporting authority to have regard to our answers but we hope that they will provide clarity over: the reporting process, how to use the Statutory Guidance, scientific evidence, and what will happen to the reports. If reporting authorities feel there are omissions to the pack, please let the Adapting to Climate Change Programme know[3] so that we can keep it as an up to date source of information.

We look forward to working closely with your organisation throughout the development of its report. If you would like to discuss this further please contact Sally Belfield (Sally.Belfield@defra.gsi.gov.uk 0207 238 4570) or Helena Busby (Helena.Busby@defra.gsi.gov.uk).

Please confirm receipt of the Direction by sending an email to acc_reportingpower@defra.gsi.gov.uk.

I am copying this letter to Ofwat, and WaterUK.

Yours sincerely,

Clare Hawley
Adapting to Climate Change Programme
Department for Environment, Food and Rural Affairs

[2] http://www.defra.gov.uk/environment/climate/legislation/reporting.htm
[3] Please send an email to: acc_reportingpower@defra.gsi.gov.uk

## Direction

# Climate Change Adaptation Report by South East Water Ltd Direction 2010

The Secretary of State has been conferred powers by section 62(1) of the Climate Change Act 2008 to direct certain persons or bodies known as "reporting authorities"[1] to give reports about adaptation to climate change.

He makes the following Direction to South East Water Ltd under the powers conferred by that section:

### Citation and Commencement

1. This Direction may be cited as the Climate Change Adaptation Report by South East Water Ltd Direction 2010. It has immediate effect.

### Interpretation

2. -In this Direction-
   "the reporting authority" means South East Water Ltd

### Direction

3. The reporting authority must prepare and send to the Secretary of State a report containing:
   (a) an assessment of the current and predicted impact of climate change in relation to the reporting authority's functions;
   (b) a statement of the reporting authority's proposals and policies for adapting to climate change in the exercise of its functions and the time-scales for introducing those proposals and policies.

4. The assessment of impact referred to in paragraph 3(a) must include:
   (a) a summary of the statutory and other functions of the reporting authority;
   (b) the methodology used to assess the current and predicted impacts of climate change in relation to those functions; and
   (c) the findings of the assessment of the current and predicted impact of climate change in relation to those functions.

5. This report must be prepared by **31 January 2011**.

[1] See the definition of "reporting authority" in section 70 of the Act.

**Representations as to information that should not be published.**

6. The reporting authority must, in its report, make representations as to any information in its report which it considers should not be published. Representations must demonstrate that this information is information that the Secretary of State is not obliged to publish on the basis that it meets one of the exemptions in section 63 (7) of the Climate Change Act 2008, namely:
   (a) that it is information which the Secretary of State could refuse to disclose in response to a request under the Freedom of Information Act 2000, or the Environmental Information Regulations 2004 (SI 2004/3391) or any regulations replacing those regulations; or
   (b) that it is information whose disclosure is prohibited by any enactment.

Signed by Authority of the Secretary of State,

Clare Hawley
A Senior Civil Servant in the
Department for Environment, Food and Rural Affairs

## Explanatory Note

*(This note is not part of the Direction)*

This Direction requires the reporting authority to prepare a report about the impact of climate change on the reporting authority's functions and policies, and its proposals for adaptation. The reporting authority is required by section 63(5) of the Climate Change Act 2008 to send a copy of the report to the Secretary of State to publish. This report must be sent as soon after preparation as is reasonable.

This Direction does not apply in respect of any devolved functions of the reporting authority.

This Direction does not apply in respect of any activities of the reporting authority which are: (i) outside of the United Kingdom; and (ii) which do not relate to any of its functions within the UK that are of a public nature or are part of its role as a statutory undertaker.

In preparing the report, the reporting authority is required by section 63(3) of the Climate Change Act 2008 to have regard to:

(a) the guidance issued by the Secretary of State under section 61 of the Climate Change Act 2008.

If the time between the issuing of any of the guidance or reports and the deadline for the report is very limited then it may be unreasonable to expect the guidance or reports to be taken into account. If so, the reporting authority should note that the requirement in section 63(3) of that Act to take these reports and guidance into account is qualified by the words "so far as relevant".

In preparing the report, if the reporting authority has functions that are exercisable in or as regards Wales or has devolved Welsh functions, then by section 63(4) of the Climate Change Act 2008 it must have regard so far as relevant to any guidance issued by the Welsh Ministers under section 66 of that Act and the most recent report under section 80 of that Act.

The reporting authority is required by section 63 (8) of the Climate Change Act 2008 to have regard to the report in exercising functions other than its devolved functions.

Compliance with this Direction is a statutory obligation (section 63(1) Climate Change Act 2008).

# Appendix B – Climate Change Impacts Matrix

**Table B.1 – Climate change impacts matrix**

| Impact | | | | Risk Assessment | | | | Evidence | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Business Function** | **Climate Variable** | **Potential Impact** | **Description** | **Sensitivity / Threshold** | **Change in Exposure** | **Assessed Risk** | **Overall Risk (L / M / MH / H)** | **Evidence / Source** | **Pedigree (A - D)** | **Overall Score** | **Gaps?** |
| Water resources, Asset management, etc | Temp, mean rainfall, extreme rainfall, etc | | What is the nature of the risk? | Is there a threshold above which this impact will have affect the business function? If not, what are the perceived sensitivities? | How is the impact perceived to change in the future? What method/approach was used? | | Overall risk | What report/study did this come from? | e.g. B | **e.g. B-M** | Any obvious gaps in the evidence? |
| Water Resources | Multi-season low rainfall; PET | **Reduction in surface water availability** | Reductions in rainfall, particularly during consecutive seasons, with corresponding increases in year-round PET can reduce reservoir refill capability. Winter recharge is likely to increase, though how changes in interannual variability are more uncertain. | Not formally assessed by SEW. | The impact of climate change on DO has been factored into forecasts of DO, using the UKCIP02 Medium scenario ('Mid'). Uncertainties have been included in the target headroom allowance, using the CCSR/NIES model as a conservative estimate ('Wet') and ECHAM4 as a worst-case scenario ('Dry').<br><br>Headroom modelling followed UKWIR (2002) guidance; a triangular distribution was skewed to 60% dry, 40% wet. | The best estimate forecast is a reduction in water supplies of 1.7% by 2020 (compared to present) and by 2.6% by 2035. | **MH** | SEW's draft WRMP assessment following the approach of the EA WRPG (see Chapter 4).<br><br>Headroom modelling in WRMP Appendix 6.1 (p16). | **A** | **A-MH** | No assessment of sensitivity to climate thresholds.<br><br>No assessment of drought triggers under climate change. |
| Water Resources | Multi-season low rainfall; PET | **Increased competition for shared water resources** | The Water Resources in the South East (WRSE) Group, driven by the EA, may require companies to work more closely in managing shared resources, e.g. the River Medway Scheme and Southern Water. Greater numbers of sustainability reductions may also be imposed. Climate change is likely to emphasise a much more integrated strategy across the region. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | SEW's draft WRMP (section 8.1.4). | **A** | **A-M** | |
| Water Resources | Multi-season low rainfall; PET | **Risk of non-renewal of time limited licences or existing licences being modified** | SEW operates in a water stressed area so there is already increasing scrutiny and risk to existing abstraction licences. This is likely to increase with a change in climate due to changes in hydrology. Increases in evapotranspiration and lower rainfall in summer periods will result in lower flows in rivers. Increases in rainfall intensity may result in flashier river flows, reducing the period of time available to exploit peak flows. Licences may need to be altered to maintain the balance between environmental needs and public water supply. | Subject to the findings of EA investigations | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | South East and Thames River Basin Management Plans | **A** | **A-L** | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Water Resources | Mean Temp; Max Daily Temp | **Increasing demand in warmer weather** | Warmer weather likely to result from climate change is likely to result in increased demand for water, in particular with respect to personal hygiene, washing, domestic garden watering and other external uses of water. | Not formally assessed by SEW beyond requirements of WRMP and BP processes.<br><br>Some consideration of demand as a trigger for drought in the Drought Plan, for past/current conditions only: worst-case scenarios for ADD and ADPW used as drought trigger - currently 2002/03 demand profile is used for MKW. | Predictive relationships between climate change and demand developed using UKCIP02 Low, Medium and High scenarios<br><br>The uncertainties for demand are large, and have been included within the assessment of Target Headroom (NB, this was based on SEW work, not HRW).<br><br>A separate study for MKW only found average demand will increase by 2.6% (1.3 to 4%) by the 2020s using the same models as in the supply modelling. The 'Mid' scenario is higher than PR04 (1.7%) and national average in CC:DeW (1.3%). | Mid Range Estimates have been adopted - +2% in pcc by 2020 and +4% by 2040 (increasing linearly from the base year), for all household consumption groups, and for measured and unmeasured households. | **MH** | SEW's draft WRMP assessment following the approach of the EA WRPG (see Chapter 5 - p133)<br><br>Drought Plans - drought triggers<br><br>WRMP Appendix 2.10 for MKW-specific work by HRW (not clear if this was subsequently used in the fWRMP).<br><br>Headroom modelling in WRMP Appendix 6.1 (p18). | **A** | **A-MH** | No assessment of sensitivity to climate thresholds.<br><br>No assessment of drought triggers under climate change. |
| Water Resources | Multi-season rainfall | **Reduction in groundwater availability** | Reductions in rainfall, particularly during consecutive seasons, will reduce the amount of groundwater recharge that occurs, hence decreasing the availability of groundwater resources to meet demand. | A comparison of 1 in 50-yr droughts compared to 1 in 100-yr (to simulate climate change) showed a total of 15 groundwater sources in WRZ 2-5 will have slightly reduced DOs during a '1 in 100' year drought event; typically -1% to -5% in PDO and -1% to -6% in ADO.<br><br>Some consideration of groundwater levels, recharge and SMD as triggers of drought in the Drought Plan, for past/current conditions only. e.g. for MKW, anything below LTA groundwater level is classed as 'mild ' or 'moderate' drought, below historical minima is 'severe' drought. Also, below LTA of 3-year cumulative recharge is classed as a 'mild drought', with <80% of LTA and <60% of LTA classed as 'moderate' and 'severe' droughts respectively. | Given the uncertainties that exist around climate change input scenarios and output estimates, the Company has included the difference between the 'Mid' scenario and both the 'Wet' and 'Dry' scenarios as a component of uncertainty in the Target Headroom assessment.<br><br>Headroom modelling followed UKWIR (2002) guidance; a triangular distribution was skewed to 60% dry, 40% wet. | At Company level, ADO from groundwater sources is reduced by 5.0 Ml/d (-1.0%) by 2020, and by 8.8 Ml/d (-1.8%) by 2035. PDO from groundwater sources is reduced by 4.1 Ml/d (-0.7%) by 2020, and by 7.9 Ml/d (-1.4%) by 2035. | **H** | SEW's draft WRMP assessment following the approach of the EA WRPG (see Chapter 4 - p88-90)<br><br>Drought Plans - drought triggers<br><br>Drought severity comparison - WRMP Appendix 2 (by Aquaterra & HRW)<br><br>Headroom modelling in WRMP Appendix 6.1 (p16). | **A** | **A-H** | No assessment of sensitivity to climate thresholds.<br><br>Some assessment of changing drought DO under climate change. No specific assessment of drought triggers under climate change. |
| Water Resources | Winter rainfall | **Increase in winter recharge** | Increase in winter rainfall providing the opportunity for increased storage. | Not formally assessed by SEW. | As part of the WRMP, for both groundwater and surface water sources, SEW has modelled the impact of climate change on recharge at the individual source level. An increase in recharge is included as part of the 'Wet' scenario as described above. | Opportunity rather than a risk. | **M** | CCRA (Water) | **C** | **C-M** | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Asset Management | Extreme Rainfall | **Increase in risk of fluvial flooding** | Increased frequency of extreme rainfall events will heighten the risk of river levels rising and causing fluvial flooding of water company assets. | Where available, a range of AEPs is considered but typically flood data is limited to Environment Agency Flood maps showing only Flood Zones 3 and 2. Where detailed hydraulic modelling has been carried out by the Environment Agency then usually flood events ranging from 1 in 10 to 1 in 100 AEP are available including a climate change scenario using the 1 in 100 AEP event but with flows increased by 20% (in the South East this climate change event tends to equate to 1 in 200 AEP flood levels). | Not formally assessed by SEW. | Not formally assessed by SEW. | **H** | SEW FRA and SSoS reports | **B** | **B-H** | FRA and SSoS reports do not contain a description of how climate change is assessed. FRA mentions the requirement to include it, but nothing more. |
| Asset Management | Extreme Rainfall | **Increase in risk of groundwater flooding** | Increased frequency of extreme rainfall events will heighten the risk of groundwater levels rising and causing flooding of both underground and above-ground water company assets. Flooding of service trenches will also inhibit the ability of SEW to repair leaks. | As above | Not formally assessed by SEW. | Not formally assessed by SEW. | **MH** | SEW FRA and SSoS reports | **B** | **B-MH** | |
| Asset Management | Extreme Rainfall | **Increase in risk of surface water flooding** | Increased frequency of extreme rainfall events will heighten the risk of surface water flooding of water company assets, particularly in areas where SUDS are not present. Flooding will also reduce the mobility of SEW staff to access sites and detect and repair leaks in inundated areas. Risk of flooding exacerbated where development results in permeable surfaces are replaced with paved areas within catchments. | As above | Not formally assessed by SEW. | Not formally assessed by SEW. | **H** | SEW FRA and SSoS reports | **B** | **B-H** | |
| Asset Management | Sea level rise | **Increase in risk of tidal/coastal flooding** | Sea level rise may expose SEW assets to both erosion and flooding with saline water. Impacts will clearly be greater at coastal sites, but those situated on estuaries will also be vulnerable. Consideration of the risk of tidal flooding may also limit the favourability of particular resource options, e.g. desalination plants, in future options appraisals. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | UKWIR CL01 | **C** | **C-L** | |
| Asset Management | Extreme rainfall events | **Risk to dam safety** | This impact relates to the capacity of dam spillways to deal with high volumes of water from extreme rainfall events that could lead to dam overtopping and erosion of the embankment materials, leading to dam failure. The structural stability and therefore safety of dams is also vulnerable to extended periods of low rainfall, fluctuations in water level and extremes of temperature. The results of these climatic impacts, respectively, include desiccation of clay cores, increases in pore pressure leading to erosion, and thermal cracking. | Not formally assessed. Panel engineer responsible for ensuring dams and reservoirs meet safety standards. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | Initial outputs from Defra study on the impact of climate change on reservoirs and dams | **C** | **C-L** | No assessment of risks to SEW's reservoirs and dams. |
| Asset Management | SMD | **Risk to structural stability of dams** | Soil conditions may exhibit increasing variability as a result of changes in inter-annual temperature and rainfall regimes, which may affect slope and structural stability, as described above. | Not formally assessed. Panel engineer responsible for ensuring dams and reservoirs meet safety standards. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | Initial outputs from Defra study on the impact of climate change on reservoirs and dams | **C** | **C-L** | As above |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Asset Management | Daily min temperature; snow cover | **Increases in Leakage / Burst Frequency** | While low temperature extremes and snowfall are predicted to decrease – and thus reducing the risk of burst frequencies and leakage through freeze-thaw weathering, reducing soil moisture in dry spells will increase the risk of heave and associated damage to pipes. | Not formally assessed by SEW. | The Company expects that its ageing asset base will further exacerbate the risk of bursts in future alongside low temperature extremes.<br><br>UKCIP02 was used to derive climate change scenarios that demonstrated potential changes in key variables for use in SEW's Capital Maintenance Planning model:<br><br>Max and Min temperature<br>Frost days (no. days per month where min temperature is <0$^{o}$C)<br>Sunshine hours | Impact on asset deterioration or expenditure?<br><br>Do climate change perturbed variables result in significantly different asset deterioration profiles and do they trigger significantly different expenditure levels? | **MH** | SEW's Special Report to Ofwat: Impact of the recent cold weather on burst mains, Distribution Input and leakage (February 2010) | **A** | **A-MH** | ***No correlation analysis to quantitatively assess sensitivity of burst frequency to climate thresholds.*** |
| Asset Management (and Water Quality) | Extreme rainfall events | **Increased risk of sedimentation/siltation** | Extreme rainfall events will cause increased runoff rates and increased sediment mobility, resulting in increased conveyance of fine sediment and also large sediment into reservoirs and rivers, causing siltation. | Not formally assessed. A risk in some specific reservoirs, but not all. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | South East and Thames River Basin Management Plans - Annex G: Pressures and Risks | **C** | **C-L** | No long-term research into potential future problems under climate change. |
| Asset Management | Multi-season low rainfall | **Asset deterioration through sediment settlement** | Multi-season low rainfall events would reduce the frequency of flushing flows passing through catchments, resulting in potential siltation of intake structures, particularly on rivers. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | CCRA (Water) | **C** | **C-L** | As above |
| Asset Management (and Water Quality) | Extreme rainfall events, Mean rainfall, daily max temperature | **Variable water quality affecting treatment processes** | Greater variability in water quality as a result of both variable dilution potential associated with flow extremes and differing pollutants in raw water from altered land practices, may affect the efficacy of water treatment processes. Single-stage treatment processes will be particularly vulnerable to this. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | South East and Thames River Basin Management Plans - Annex G: Pressures and Risks | **C** | **C-M** | As above |
| Asset Management | Extreme rainfall events | **Increase in outages from bad weather affecting assets and power supply** | The frequency of outage events resulting from both extreme rainfall and low flow is likely to increase with climate change. Outages from more persistent environmental change and cumulative effects of causal factors can also lead to an increase in outage frequency. An increase in outage will impact SEW's supply-demand balance and the operation of sites. This may also impact upon SEW's DG3 'interruptions to supply' reporting, which is considered by the economic regulator, Ofwat. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **H** | Dialogue with SEW staff (at workshop) | **D** | **D-H** | Difficult to quantify as it takes into account many different potential impacts, but currently no consideration of how risks may change. |
| Asset Management | Extreme rainfall events; snowfall | **Maintenance access difficulties in bad weather** | Access to SEW sites for operations staff and delivery vehicles or the ability to operate leak detection and repair services may be inhibited by extreme rainfall and flooding. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with SEW staff (at workshop) | **D** | **D-M** | No assessment of how risk may change |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Water Quality | Rising sea levels | **Saline intrusion** | Rising sea levels may cause salinity of groundwater sources, thus making them inoperable, sometimes permanently. This impact is more likely to affect sources at/near the coast. | Not formally assessed by SEW. | For those sites affected, the estimate of impact from the mid range climate change analysis has been included within the central estimates of climate change impacts on groundwater DO, with the range estimates from the low (wet) and high (dry) scenario analyses being included within the target headroom analysis | Not formally assessed by SEW. | **L** | SEW's draft WRMP assessment following the approach of the EA WRPG (see Chapter NUMBER) Initially on p89 | **A** | **A-L** | |
| Water Quality | Extreme rainfall events | **Risk of aquifer contamination from flooding** | Extreme rainfall events and associated increases in groundwater flooding may result in conveyance of pollutants through groundwater into aquifers. Existing groundwater source treatment processes may become inadequate. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | UKWIR CL01 | **C** | **C-M** | Water quality issues are covered in Water Safety Plans, but these do not consider the risk of longer-term elements such as climate change. |
| Water Quality | Extreme rainfall events | **Increased land runoff** | Increased surface runoff, identified above as being a direct result of extreme rainfall events, will provide increasing capacity for agricultural fertilisers, pesticides, herbicides and nutrients to be conveyed to river channels and thus affecting quality of sources of raw water.<br><br>Additional risk of N & P pollution | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **MH** | UKWIR CL01 | **C** | **C-MH** | As above |
| Water Quality | Multi-season low rainfall | **Reduction in water volumes and pollution dilution** | Multi-season low rainfall and associated low flows in rivers, reservoirs and aquifers, would result in lower dilution potential for pollutants - particularly sewage - and consequently higher raw water concentrations entering treatment works. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | CCRA (Water) | **C** | **C-M** | As above |
| Water Quality | Mean rainfall; daily max temperature; sunshine hours. | **Increased algae risk in reservoirs** | Lower summer flows, higher temperatures and increased solar incidence are likely to increase the risk of larger and more frequent algal blooms in reservoirs. This will heighten the need for treatment, thus increasing OPEX and potentially necessitating a capital solution. | Not formally assessed. A risk in some specific reservoirs, but not all. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with Catherine Fearon (Water Quality Manager) | **D** | **D-M** | As above |
| Water Quality | Mean rainfall | **Increased risk of cryptosporidium in reservoirs** | Higher demands as a result of increased temperatures and lower summer rainfall will mean reservoirs are drawn down more rapidly. Low residence times can increase the risk of cryptosporidium in reservoirs, thus putting sources at risk. | Not formally assessed. However, a residence time in reservoirs of above 7 days reduces risk. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | Dialogue with Catherine Fearon (Water Quality Manager) & Risk Assessment Report for Bewl Reservoir. | **D** | **D-L** | As above |
| Water Quality | Extreme rainfall events | **Increased risk of turbidity** | Extreme rainfall events can result in flashy river flow regimes. This in turn leads to greater disturbance of benthic sediment which, along with greater sediment conveyance from surface runoff, can cause increased turbidity risks at water treatment works. High turbidity levels often result in auto-shutdown of treatment works, thus impacting supply. | Not formally assessed. A risk in some specific reservoirs, but not all. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with Catherine Fearon (Water Quality Manager) | **D** | **D-M** | As above |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Water Quality | Extreme rainfall events (particularly after dry periods) | **Increasing nitrates / mobilisation of fines** | Extreme rainfall events (particularly after dry periods) will result in the mobilisation of large quantities of fine sediment. This will result in a heightened risk of siltation at intake structures and increased mobility into raw water of bound nutrients, potentially impacting treatment efficacy.<br><br>Additional risk of N & P pollution | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with David Smith (Water Quality) | **D** | **D-M** | As above |
| Water Quality | Mean Temp | **Reduced dissolved oxygen in surface waters** | Higher temperatures and/or reduced flows may cause a reduction in dissolved oxygen in surface waters; increasing the need for further treatment because of the reduced ability of receiving waters to cope with pollution. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | CCRA (Water) | **C** | **C-L** | |
| Water Quality | Mean Temp | **Increased efficiency of water treatment processes** | Increased temperatures will speed up chemical and biological treatment processes for water | Not formally assessed by SEW. | Not formally assessed by SEW. | Opportunity rather than a risk. | **M** | CCRA (Water) | **C** | **C-M** | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy & Carbon | Mean Temp; Max Daily Temp; Mean Rainfall | **Increasing energy demand in warmer/drier weather** | Demand for water increases in warm, dry weather, which increases treatment and pumping requirements and hence energy use. This has both financial and carbon implications. | Demand is forecasted on an annual basis in the water resources plan and then revised and reforecast as necessary on a monthly basis. Dry year demand is used as a basis for forecasting demand in hot spells, but no specific assessment for climate change. | Not formally assessed. Increasing likelihood of hot spells in summer may affect energy demand. | Not formally assessed by SEW. | **M** | Dialogue with Kevin Clark (Energy Efficiency Manager) | **D** | **D-M** | No forecasting on longer-term. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Biodiversity & Conservation | Mean temp; multi-season low rainfall | **Increasingly difficult management and improvement of conservation areas (e.g. SSSIs)** | A changing climate is likely to alter the condition of conservation areas, thus management and preservation of baseline conditions will become increasingly difficult; a particular case would be the chalk grasslands habitat diminishing or disappearing. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | Water UK study | **C** | **C-L** | Management plans are for 5-years and so do consider impacts of climate change later in the century. |
| Biodiversity & Conservation | Mean temp; multi-season low rainfall | **Potential difficulty in meeting WFD standards** | Climate change may make it more difficult to meet the new WFD standards for all water bodies to be in 'Good' ecological condition. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with Emma Goddard (Environment Manager) | **D** | **D-M** | |
| Biodiversity & Conservation | Mean temp; multi-season low rainfall | **Potential changes to abstraction licences to protect SSSIs and wetlands** | Licensing conditions for abstractions may become stricter in order to protect European designated wetlands in supply areas. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with Emma Goddard (Environment Manager) | **D** | **D-M** | |
| Biodiversity & Conservation | Summer rainfall | **Decrease in base flows in rivers** | A decrease in river summer base flow may result in the need for alterations in the operation of reservoirs to supply rivers with compensation flow (to maintain good ecological status in the basin). | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with Emma Goddard (Environment Manager) | **D** | **D-M** | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Organisational Capacity | All | **Lack of staff awareness of climate change and associated impacts and adaptation options** | The impact of climate change on operations is likely to impact all SEW staff in some way in the future, e.g. in operation of sites, access to sites or responding to customer enquiries or complaints. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | PACT Report | **B** | **B-M** | |
| Organisational Capacity | All | **Higher numbers of customer complaints arising from greater frequencies of extreme events** | Greater frequencies of extreme events, such as heatwaves causing greater frequencies of demand restrictions, and flooding causing disruptions to supply, will result in higher numbers and different types of customer enquiries or complaints. Customers will expect SEW to take all actions such that predicted climate change is planned for. This may in turn impact upon SEW's performance against Ofwat's Service Incentive Mechanism and other comparative assessments. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Water UK study | **C** | **C-M** | |
| Organisational Capacity | Extreme events (any) | **Increased risk of loss of service from suppliers - e.g. electricity, chemical suppliers, etc** | SEW may be affected where suppliers cannot deliver a service on which SEW relies, such as power, supply-chain requirements (e.g. chemicals) and personnel/contractors. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with Matt Hersey (Econometric & Performance Manager) | **D** | **D-M** | |
| Facilities Management | Daily max and min temperature | **Increased need for air conditioning in summer and heating in winter** | Increased temperature variability may impact upon working conditions for SEW staff, both in offices and vehicles. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Water UK study | **C** | **C-M** | |
| Facilities Management | All | **Potential risk of spread of disease in trees in SEW landholdings** | Potential increase in spread of major tree diseases as a result of climate change. Potential liability for trees on SEW landholdings. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | Dialogue with Emma Goddard (Environment Manager) | **D** | **D-L** | |
| Facilities Management | Mean rainfall; daily max temperature; sunshine hours. | **Potential public health impact of algal blooms in reservoirs used for recreation** | Algal blooms in reservoirs may result in safety and public health problems, and potential for claims against SEW because of ill health. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | Dialogue with Emma Goddard (Environment Manager) | **D** | **D-L** | |
| Financing | All | **Vulnerability to political stances on climate change** | Changes to political stances in relation to climate change may impact upon SEW if increased scrutiny of adaptation efforts arises which could potentially impact upon the Company's reputation. It may also require the Company to focus more on particular measures, e.g. metering. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | 2030 Water Resources Group (2009) Charting Our Water Future - Economic frameworks to inform decision-making, McKinsey Quarterly | **C** | **C-M** | No assessment of financial implications of climate change on company level |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Financing | All | **Reduced financial rating of UK water companies** | Climate change and the vulnerability of companies to its effects may become a measure by which companies' credit ratings are assessed and which may affect investor confidence and in turn the cost of capital. This impact is likely to be low for SEW as a regulated company. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **L** | 2030 Water Resources Group (2009) Charting Our Water Future - Economic frameworks to inform decision-making, McKinsey Quarterly<br><br>CCRA (Water) | **C** | **C-L** | As above |
| Financing | All | **Greater OPEX reflecting additional impacts of climate change** | Higher operational costs as a result of the impacts listed here. | Not formally assessed by SEW. | Not formally assessed by SEW. | Not formally assessed by SEW. | **M** | Dialogue with SEW staff | **D** | **D-M** | |

# Appendix C – Adaptation Responses Matrix

**Table C.1 – Adaptation Options Matrix**

| Impact | Adaptation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Potential Impact** | **Potential Adaptation Options** | **Description** | **Barriers** | **CBA (L / M / H Cost:Benefit)** | **Timescale (S / M / L)** | **Sustainability Principles (↓ / ↑ / -)** | | | **Carbon Impact (L / M / H)** | **Potential Regret (H / M / L / No)** | **Comments** |
| | | | | | | **Environmental** | **Economic** | **Social** | | | |
| Selected risk carried through from Impacts Matrix | Long list, from literature, workshop, etc | More detail on the option | Any barriers to successful implementation of the option? | Cost-benefit ratio (for OPEX and CAPEX) | Time period over which the adaptation is required | A category of ↑↓ or - for whether the option improves, worsens or maintains the principle. Short-term (ST) / Long-term (LT) where these differ | | | What is the impact of the option on carbon emissions? | What is the potential that the option may be regretted later? Does it have wider benefits? Can it be altered later? | Further comments and justification of scoring |
| **Reduction in surface water availability** | **Develop conjunctive use schemes** | Reducing groundwater abstraction during winter periods so as to maximise aquifer recharge, in conjunction with increased use of other available resources; balancing the use of resources within integrated resource systems. | Water quality may be reduced for some high flows, reducing WAFU | **L:M** | **M** | ↑ | – | – | **L** | **L** | Wider environmental benefit of more suitable use of both resources; reduced pumping costs of GW during winter. |
| | **Increase reservoir capacity** | This option is included as a measure to manage climate change impact alone. Constructing of strategic storage bodies to hold water, abstracted from rivers at potential locations in Kent and Sussex, during periods of high flow, for potable supply across the company as well as locally. Reservoirs schemes are more resilient to drought than direct river abstractions and, although their construction will have some immediate environmental effects, they can provide community and environmental benefits in the long term. | Planning regulations and difficulty finding suitable sites.<br><br>Environmental cost of construction, and social cost of moving homes or other developed areas. However, scale of impact on local residents will depend on the exact nature of the scheme. | **H:H** | **L** | ↓(ST)<br>↑(LT) | ↓(ST)<br>↑(LT) | ↓(ST)<br>↑(LT) | **M** | **H** | Although significant, the environmental and social costs are largely short-term, and once built a reservoir can provide wider benefits. These include opportunities for conjunctive use and interconnectivity across the southeast.<br><br>The option is potentially high regret because a significant investment decision is required (despite uncertainty) well in advance of needing the additional supply, due to the length of time before it comes online. However, there is also potential for regret in the reverse situation. |
| | **Reduce water lost through leakage** | Further reducing leakage from the Company's distribution system, through 'find and fix' programmes or pressure reduction measures. | Costly programme with no guarantee of large savings of water.<br><br>Cost for repairs needs to be traded off against investment in renewal. | **H:L** | **S** | ↑ | ↑ | – | **L** | **L** | Wider benefits of reducing leakage include reduction of repeat-treatment of potable water lost and improvement of customer and media perception.<br><br>Assumes greater economic value placed on leakage reduction. |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **New surface water abstraction** | New surface water abstraction – from various rivers across the Company's supply area. | Many rivers are already highly impacted by existing public water supply abstractions. The implementation of the WFD is likely significantly to reduce the potential for run-of-river abstractions: unless they can be supported by storage, these are very vulnerable to low flows during drought conditions, when abstraction cannot occur. Water quality may be reduced for some high flows, reducing WAFU.<br><br>Water quality could be a constraint on abstraction in future in order to manage water quality where effluent is already at best practice treatment.<br><br>Not viable unless adequate storage and strong conjunctive use system are already in place. | **M:M** | **L** | ↓ | – | – | **L** | **M** | Potential wider environmental impact of further extraction from surface water surfaces. |
| **Desalination** | Abstracting saline or brackish water from boreholes, estuaries or the sea and treating it to a potable standard using reverse osmosis technology. | Desalination plants have high electricity demands, therefore they are relatively costly to operate and have a correspondingly large carbon footprint. They also produce a highly saline discharge that needs treatment before it can be returned to the natural environment. Desalination is most often used as a peak-load or stand-by option where there is a need for a high degree of security of supply, making the high unit cost acceptable. | **H:M** | **L** | ↓ | ↓ | – | **H** | **H** | Very high energy demands make this option less suitable for a low carbon society. High regret because of both the high capital and operational costs in advance of requirement. |
| **International transfer** | Importing raw water from abroad, using marine tankers or, for example, by towing icebergs. | Untested and likely to be prohibitively expensive.<br><br>Political implications. | **H:M** | **M** | ↓ | ↓ | ↓ | **H** | **H** | Energy and/or fuel use in transfers makes this option less suitable for a low carbon economy. |
| **National transfer** | Importing raw water from other UK water companies using underground mains (which would require the construction of a national water grid or by conventional sea or road tankers). | Long distance movement of water is expensive and unlikely to be cost effective. | **H:M** | **L** | ↓ | ↓ | – | **H** | **H** | Investment in logistics makes this an expensive option requiring substantial collaboration with other companies. |
| **Inter-company transfer** | Importing treated water from neighbouring water companies. Several such arrangements are already in place across the Region and the Company considered various options to augment or amend agreements that the Company has with its neighbours. | Substantial pumping costs to move water. | **M:M** | **S** | – | – | – | **M** | **M** | High energy and financial cost of implementation, although could be beneficial if movement of surpluses avoids higher costs locally. |
| **Intra-company transfer** | Improving internal connectivity around the Company's distribution network by the construction of new mains and/or pumping stations. | Substantial pumping costs to move water. | **L:M** | **S** | – | – | – | **M** | **L** | High energy and financial cost of implementation, although could be beneficial if movement of surpluses avoids higher costs locally. |
| **Maximising reservoir yield** | Increase storage capacity of existing reservoirs through removal of silt and sediment, thus taking advantage of increasing winter rainfall without the need to build new reservoirs. | Finite benefit, and requires continued effort to maintain increased yield. | **L:M** | **S** | – | – | – | **L** | **L** | |
| **Effluent re-use** | Using effluent as a source of water and nutrients for crop and pasture applications. Effluent can be treated in settling pond/s before usually being applied through spraying. | Customer and media perception.<br><br>Potential health implications where pathogens, pollutants (e.g. metals), etc are not removed from water and then reused.<br><br>Wider environmental/ecological impacts, including air pollution.<br><br>Effluent should not be sprayed during heavy rainfall because of runoff issues. | **M:M** | **M** | ↑ | – | – | **L** | **M** | Positive environmental impact as effluent is not being discharged directly into the environment; though this may result in lower flows in summer when WWTWs can make up a significant proportion of flows in some watercourses. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reduction in groundwater availability** | **Develop conjunctive use schemes** | Reducing groundwater abstraction during winter periods so as to maximise aquifer recharge, in conjunction with increased use of other available resources; balancing the use of resources within integrated resource systems. | Water quality may be reduced for some high flows, reducing WAFU | **L:M** | **M** | ↑ | – | – | **L** | **L** | Wider environmental benefit of more suitable use of both resources; reduced pumping costs of GW during winter. |
| | **Artificial recharge** | Recharging an aquifer with surface water through human effort, usually then recovered through wells. It requires a structure to keep surface water in a place where it can percolate down into the aquifer, or the means for direct injection. Useful during winter periods of high flow, for storage and later abstraction during summer periods. | Uncertain yields, and requires headroom in an aquifer to be viable. | **M:M** | **M** | ↑ | – | – | **L** | **M** | Medium regret because initial investment to get option operational is high. |
| | **Aquifer storage and recovery (ASR)** | ASR is a specific form of artificial recharge, where potable water is placed specifically into an aquifer, usually through a well, and that same water is then abstracted (through the same well) at a later time, ideally without then requiring further treatment. | Requires extensive testing prior to implementation. | **H:M** | **M** | ↑ | – | – | **M** | **M** | Medium regret because initial investment to get option operational is high. |
| | **Relaxation of abstraction restrictions** | More flexible abstraction licensing to take account of real-time catchment conditions | Water quality could be a constraint on abstraction in future in order to manage water quality where effluent is already at best practice treatment. | **L:L** | **L** | ↓ | – | – | **L** | **H** | Greater risk of over abstraction, hence negative impact on wider environment. High regret as impact may not be short-lived. |
| | **New groundwater abstraction** | Increasing groundwater abstraction from various aquifers across the region. | Water quality could be a constraint on abstraction in future in order to manage water quality where effluent is already at best practice treatment.<br><br>Most aquifers in Kent and East Sussex are already significantly utilised for public water supply abstraction and few viable high-yielding options remain available for consideration (but this varies with location and quantity). | **H:L** | **L** | ↓ | – | – | **L** | **M** | Greater risk of over abstraction, hence negative environmental impact. |
| | **Abstraction licence trading** | Trading under-utilised industrial abstraction licences, enabling the unused licence quantity to be employed by the Company for potable supply. | Setup and monitoring the system. Monitoring actual abstraction by each party.<br><br>May have limited potential in the SEW region. | **L:M** | **S** | – | – | – | **L** | **L** | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Increasing demand in warmer weather** | **Tariff change to encourage saving water** | Amending tariffs to increase the cost of water progressively with use (particularly with discretionary uses). Use of incentives to encourage water saving. Current price of water relatively low so doesn't encourage wise use. | Customer acceptability and media perception.<br><br>Requires metering (currently financed to 70% for this AMP, with plans for 90% for next). | **M:L** | **S** | ↑ | – | ↓ | **L** | **M** | Potentially a negative social impact because of restrictions on usage.<br><br>Potential regret where programme does not result in reduced usage levels. Where efficiencies are found, this could lead to difficulties finding further savings during periods of drought. |
| | **Monitoring customer views on frequency of demand restrictions** | Engage with customers to garner their views on demand restrictions and willingness to pay. | Customer acceptability and media perception.<br><br>Requires metering (currently financed to 70% for this AMP, with plans for 90% for next). | **M:L** | **S** | – | – | ↓ | **L** | **M** | Potentially a negative social impact because of restrictions on usage.<br><br>Potential regret where programme does not result in reduced usage levels. Where efficiencies are found, this could lead to difficulties finding further savings during periods of drought. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Expand discretionary use restrictions** | Increase the uses of water that are classified as 'discretionary' and hence are easier to restrict in periods of drought. | Customer acceptability and media perception. | **L:L** | **S** | **–** | **–** | **↓** | **L** | **M** | Potentially a negative social impact because of restrictions on usage. |
| | **More input to new housing development planning** | Currently SEW have a duty to supply for new developments but little input on strategy for new homes. This makes long-term planning more difficult, and added problem that demand will continue to rise. | No direct input from SEW on planning process – not a statutory consultee, though do comment. | **L:L** | **M** | **–** | **–** | **–** | **L** | **L** | Low regret, but benefit may be limited if SEW voice not heard. |
| | **Reduce demand through household water efficiency measures and customer marketing campaign.** | Promotion of water efficiency measures and appliances to encourage wise use. | Appliances don't use water, people do - difficult to push and maintain water efficiency. | **M:L** | **M** | **↑** | **–** | **–** | **L** | **M** | Potential regret where programme does not result in reduced usage levels. Where efficiencies are found, this could lead to difficulties finding further savings during periods of drought.<br><br>Reduction of flexibility during droughts because customers have already reduce demand. |
| | **Relaxation of barriers to demand options being funded through price review** | Promote the relaxation of regulations that restrict the funding of demand measures through prices. | Customer acceptability and media perception. | **L:L** | **M** | **–** | **–** | **–** | **L** | **L** | |
| | **Implement rainwater harvesting and grey-water reuse for domestic/commercial customers.** | Encourage - through awareness and discounted equipment - the use of rainwater and greywater for garden watering, car washing, etc. | Increased interception of rainwater may have an impact on watercourses.<br>Customer acceptability and media perception.<br>Restrictions from regulator on funding demand measures through pricing.<br>Limited usefulness during prolonged drought. | **M:M** | **M** | **↑** | **↑** | **–** | **L** | **L** | Reduction in water treatment costs as more water reused. Benefits dependent on reliability and usefulness in drought. |
| | **Increase in metering** | Beyond existing penetration levels, using compulsory metering powers available with the permission of the Secretary of State for Defra, in addition to optant metering, change of occupier metering and high consumption metering policies already in place, so as to enable customers to secure financial gain from reducing their use of water. | Increase in metering may not result in reduction in usage due to customer acceptability.<br><br>No clear link between universal metering plan and communication with customers; customers don't necessarily trust the messages from SEW. | **M:M** | **M** | **↑** | **–** | **–** | **L** | **L** | Potential regret where metering does not result in reduced usage levels. Where efficiencies are found, this could lead to difficulties finding further savings during periods of drought.<br><br>Reduction of flexibility during droughts because customers have already reduce demand. |
| | **Monitor demand in relation to weather variables** | Use existing DI or meter data complemented by collection of weather data to identify trends in demand with changes in temperature and rainfall. This information can subsequently be utilised to manage demand. | Contribution of weather variations to demand may be difficult to isolate from other influences. | **L:M** | **S** | **–** | **–** | **–** | **L** | **L** | |
| **Increase in risk of fluvial flooding** | **Review any Flood Risk Assessments that cover areas where SEW assets are sited** | This may facilitate prioritisation of high risk sites, because FRAs will contain assessments of climate change impacts on flood risk. | Plans may provide insufficient spatial detail to be of benefit to SEW in terms of its individual sites. | **L:M** | **S** | **–** | **–** | **–** | **L** | **No** | May inform any future site-specific flood risk assessments that SEW carry out. |
| | **Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments** | Investigate potential changes in return period and/or magnitude of fluvial flooding events and assess flood risk of assets as part of existing PR process. Propose to fund any adaptation schemes under the resilience driver. | Uncertainty regarding potential changes in fluvial flood return periods and magnitudes under climate change scenarios. | **M:M** | **S** | **–** | **–** | **–** | **L** | **L** | Uncertain flood frequency estimates resulting from climate change impact assessments may result in over or under estimate of necessary investment. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Review arrangements for customer service, information and support in the event of outages** | Raise awareness and review method of providing information to customers during flood events, and develop appropriate company-wide emergency response strategies. | Customer acceptability and media perception. | **L:L** | **S** | — | — | ↓ | **L** | **L** | Negative social impact as a result of varying levels of service. |
| | **Implement protection or flood-proofing of assets at high risk of fluvial flooding** | E.g. construction of bunds around high risk assets. | Likely to be expensive. | **M:H** | **L** | — | — | — | **M** | **M** | Potential regret where flood-proofing measures become inadequate or even unnecessary as flood risk changes over time. |
| | **Replacement or movement of assets at high risk of fluvial flooding** | Option would need to be risk-based, and possibly phased. May be necessary for those assets at high risk. | Likely to be expensive. | **H:H** | **L** | ↓ | — | — | **M** | **H** | Negative environmental impact due to construction requirements of re-siting assets.<br><br>High cost and high potential for regret as flood risk will change over time. |
| | **Incorporate climate change impacted flood events into topographic mapping/asset risk tool** | Identify potential fluvial flood zones under climate change scenarios and use these to assess asset risk and prioritise adaptation measures. | Uncertainty regarding potential changes in fluvial flood return periods and magnitudes under climate change scenarios at the local scale. | **M:M** | **S** | — | — | — | **M** | **L** | Low regret but uncertainty over climate change-impacted flood frequencies must be taken into account. |
| | **Amend assets' insurance policies to reflect climate change-impacted flood risk** | | Likely to be expensive. | **M:M** | **S** | — | ↑ | — | **L** | **L** | Low regret but potential high economic cost to SEW. Must be balanced against risk to the business and indirectly its customers of not having adequate insurance. |
| **Increase in risk of groundwater flooding** | **Review and upgrade where necessary pump duty and pump type at borehole sites** | This will help to ensure there is sufficient range to accommodate and make use of (where licences permit) higher groundwater levels during groundwater flood events. | Uncertainty regarding groundwater levels under future climate change scenarios, exacerbated by other influences on groundwater levels such as variations in catchment infiltration, catchment management measures etc. | **M:M** | **M** | — | — | — | **L** | **M** | Will enable greater flexibility in operation of groundwater sources, but will be expensive. Potential regret where future groundwater levels and therefore possible benefits are uncertain. |
| | **Carry out research into techniques to enable leaks to be fixed in flooded trenches** | | Reliance upon industry research. | **M:M** | **M** | — | — | — | **L** | **L** | Low regret but the option would require industry-wide consensus and action to prompt research. |
| | **Implement flood protection measures for underground water storage assets** | Review any existing mechanisms and develop options for improving the flood resilience of underground water storage assets. | Likely to be expensive. | **H:H** | **M** | ↑ | ↓ | — | **M** | **L** | Gaining access to underground assets will have a negative environmental impact due to invasive nature of the work. Will also be financially costly. |
| | **Implement changed operation and maintenance regime to deal with higher groundwater levels** | | Uncertainty regarding groundwater levels under future climate change scenarios. | **L:M** | **S** | — | — | — | **L** | **L** | Prudent approach to operation of sources. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Ensure that future below ground installations (e.g. meters) are waterproof** | | | **M:H** | **S** | – | ↑ | – | **L** | **L** | Low regret but will incur cost. |
| | **Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments** | Investigate potential changes in return period and/or magnitude of groundwater flooding events and assess flood risk of assets as part of existing PR process. Propose to fund any adaptation schemes under the resilience driver. | Uncertainty regarding potential changes in groundwater flood return periods and magnitudes under climate change scenarios. | **M:M** | **S** | – | – | – | **L** | **L** | Uncertain flood frequency estimates resulting from climate change impact assessments may result in over or under estimate of necessary investment. |
| | **Raise headworks** | Raise headworks above ground level (or higher depending on fluvial or surface water flood risk) | Security issues will need addressing | **M:M** | **M** | – | – | – | **L** | **M** | Potential regret where groundwater levels do not significantly change under climate change scenarios. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Increase in risk of surface water flooding** | **Incorporate an appropriate margin for climate change in Periodic Review asset flood risk assessments** | Investigate potential changes in return period and/or magnitude of surface water flooding events and assess flood risk of assets as part of existing PR process. Propose to fund any adaptation schemes under the resilience driver. | Uncertainty regarding potential changes in surface water flood return periods and magnitudes under climate change scenarios. | **M:M** | **S** | – | – | – | **L** | **L** | Adaptation option does not directly lead to protection against flooding, but instead assists SEW in identifying potential impacts or prioritising action, hence a Medium benefit rating. |
| | **Review arrangements for customer service, information and support in the event of outages** | Raise awareness and review method of providing information to customers during flood events, and develop appropriate company-wide emergency response strategies. | Customer acceptability and media perception. | **L:L** | **S** | – | – | ↓ | **L** | **L** | Negative social impact as a result of varying levels of service. |
| | **Implement protection or flood-proofing of assets at high risk of surface water flooding** | Options could include construction of bunds around high risk assets and ensuring that surface water drainage systems (using SUDS where possible) are sufficient to attenuate and convey water off sites. | Likely to be expensive. | **M:H** | **L** | – | – | – | **M** | **M** | Potential regret where flood-proofing measures become inadequate or even unnecessary as flood risk changes over time. |
| | **Replacement or movement of assets at high risk of surface water flooding** | Option would need to be risk-based, and possibly phased. May be necessary for those assets at high risk. | Likely to be expensive. | **H:H** | **L** | ↓ | – | – | **M** | **H** | Negative environmental impact due to construction requirements of re-siting assets.<br><br>High cost and high potential for regret as flood risk will change over time. |
| | **Review any Surface Water Management Plans that cover areas where SEW assets are sited** | This may facilitate prioritisation of high risk sites, because SWMPs will contain assessments of climate change impacts on flood risk. | Plans may provide insufficient spatial detail to be of benefit to SEW in terms of its individual sites. | **L:M** | **S** | – | – | – | **L** | **No** | Adaptation option does not directly lead to protection against flooding, but instead assists SEW in identifying potential impacts or prioritising action, hence a Medium benefit rating. |
| | **Incorporate climate change impacted flood events into topographic mapping/asset risk tool** | Identify potential surface water flood zones under climate change scenarios and use these to assess asset risk and prioritise adaptation measures. | Uncertainty regarding potential changes in surface water flood return periods and magnitudes under climate change scenarios at the local scale. | **M:M** | **S** | – | – | – | **L** | **L** | Adaptation option does not directly lead to protection against flooding, but instead assists SEW in identifying potential impacts or prioritising action, hence a Medium benefit rating. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Amend assets' insurance policies to reflect climate change-impacted flood risk** | | Likely to be expensive. | **M:M** | **S** | – | – | – | **L** | **L** | Adaptation option does not directly lead to protection against flooding, but instead assists SEW in identifying potential impacts or prioritising action, hence a Medium benefit rating. |
| **Increases in Leakage / Burst Frequency** | **Incorporate impacts of soil wetting and drying due to climate change scenarios into SEW's existing capital maintenance planning model** | This will allow analysis of pipe cracking and movement caused by soil wetting and drying. Collection of weather and soil condition data and monitoring of this against burst frequency will need to precede this analysis. | Uncertainty regarding future climate scenarios, in particular their relationship with asset deterioration factors. Awaiting publication of UKWIR project on the impacts of climate change on asset serviceability.<br><br>Isolating impacts of weather variables on pipe condition and movement is difficult due to the presence of other influences, e.g. soil type, pipe age. | **M:M** | **M** | – | – | – | **L** | **L** | Low regret but will require investment in data collection and extensive modelling, compounded by uncertainty over the potential effects of climate change scenarios on soil conditions. |
| | **Use heave-resistant pipeline materials and connected assets for system extensions / renewals** | This will enable SEW to replace existing mains with mains constructed from more flexible materials, which will be better able to withstand freeze-thaw cycles and movement caused by soil wetting and drying, thus reducing burst frequency and leakage.<br><br>Benefit in terms of greater resilience and longer lifetime of assets. | Pipes will have long lifetimes will need adequate headroom; uncertainty is large for quantifying climate change on long timescales. | **H:H** | **M** | ↑ | ↑ | ↑ | **L** | **M** | Benefits to all sustainability principles through saving of water, money (on repairs) and less disruption for customers. |
| | **Incorporate an allowance for the benefits of climate change adaptation into the sustainable economic level of leakage calculation with respect to mains replacement activity** | This would enable the presentation of a more robust economic argument for mains replacement versus other options such as rehabilitation or more active leakage control, taking into account the longer term benefits of adapting to climate change. | Likely to only be acceptable if part of an industry-wide approach. | **L:M** | **M** | – | – | – | **L** | **M** | Option would require industry-wide consensus and action to prompt research. |
| **Increase in outages from bad weather affecting assets and power supply** | **Review existing outage response procedures more frequently** | Review outage response procedures and when necessary invoke them more frequently. | | **L:M** | **S** | – | ↑ | – | **L** | **No** | Wider benefits of regular review, regardless of climate change. |
| | **Investigate alternative outage response procedures** | Investigate mechanisms for reducing the impact of power outages by, e.g. having more generators or back-up power supplies available across sites. | Costly to purchase standby power supplies and low certainty about their eventual frequency of use. | **M:M** | **M** | ↓ | ↓ | – | **L** | **M** | Potentially undesirable and costly alternatives, such as increased use of diesel generators |
| | **Continue to monitor outage events using standardised template across sites** | Ongoing collection of data will better inform Monte Carlo outage modelling, allowing SEW to plan for outage events effectively and consistently. | | **L:M** | **S** | – | ↑ | ↑ | **L** | **L** | Wider benefit includes increased ability to identify trigger points of outages, and who is worst affected. Gives potential for improvement of procedures. |
| | **Review bad weather site operation procedures** | Review remote operation capability as well as access roads and vehicle suitability to minimise outage duration. Prioritise higher risk sites. | Costly to resurface roads, provide additional vehicles or provide telemetry and low certainty about their eventual frequency of use. | **L:M** | **M** | – | – | ↑ | **L** | **L** | Potential to improve health and safety for staff. |
| | **Use of weather-related outage as a criterion for capital scheme selection** | Include climate-related outage in the scheme appraisal process e.g. based on differential risk associated with different options | Uncertainty in terms of knowledge | **L:L** | **S** | – | ↑ | – | **L** | **L** | More rigorous capital scheme selection process. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Increased land runoff** | **Consider as part of catchment management plans (such as WFD programme of measures), with climate change** | The impact of climate change to be incorporated into catchment management plans (including RBMP POMs). | Unknown constituents of run-off – soil, fertilizers, animal waste, etc make it difficult to assess with regard to climate change. | **L:M** | **M** | ↑ | ↑ | – | **L** | **No** | Wider environmental benefit, and potential economic benefit in addressing WG issues in conjunction. |
| | **Monitor and review; research into potential future changes.** | Set up a monitoring system for land runoff and fluctuations with weather events to inform future measures. | | **M:M** | **M** | ↑ | – | – | **L** | **L** | Greater knowledge and understanding of climatic drivers in WQ issues. |
| | **Liaison with stakeholders (e.g. NFU).** | Discussion with landowners and users on their needs and foster partnerships in reducing run-off problems. | | **L:M** | **M** | ↑ | – | ↑ | **L** | **No** | Potential to improve relationship with stakeholders and take advantage of their knowledge and experience, for the wider benefit of the environment. |
| | **Education and awareness on management practices for land owners.** | Awareness-raising of the problems/costs involved in treating water and encourage improved land management techniques. | Regulator not keen on SEW subsidising farmers to help pay for improvements. | **L:L** | **M** | ↑ | – | ↑ | **L** | **No** | Potential to improve relationship with stakeholders and take advantage of their knowledge and experience, for the wider benefit of the environment. |
| | **Expand water treatment capability** | Accept worsening water quality and increase water treatment capacity to cope. | | **H:H** | **L** | – | ↓ | ↓ | **M** | **H** | Increased cost of water treatment, which may affect customer bills. High regret as the option requires capital investment. |
| | **Partial treatment options for water to be used for gardens, car-washing, etc; point of use devices rather than centralised treatment; associated changes in standards.** | Promote water reuse and use of partially-treated water; possibly with point of use devices for water treatment. | Public health perception issues. Water will have to be highly chlorinated and near potable anyway. | **H:L** | **L** | ↑ | – | – | **L** | **H** | Potential for regret if investment doesn't get support from users. |